COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

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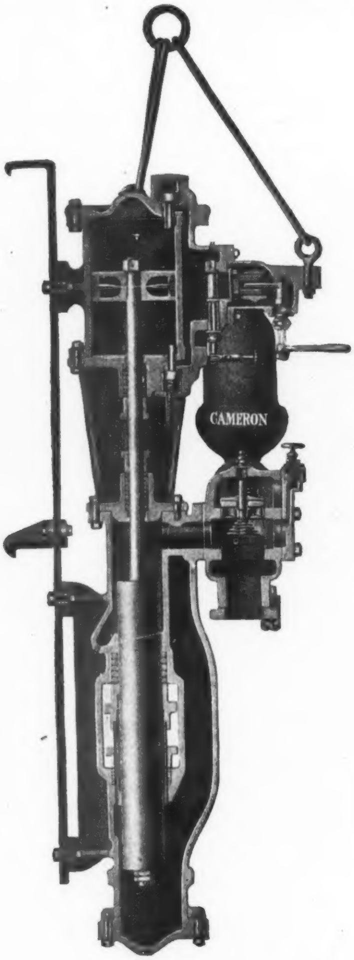
The Slogan of the Cameron:—"Character: The Grandest Thing."

CAMERON MINE SINKING PUMP

IS THE LEADER THE WORLD OVER



The Sectional View of a CAMERON SINKING PUMP shown herewith gives a comprehensive idea of its design and construction. There are no outside valve gears or rods in Cameron Pumps to get out of order.

This pump is easily and quickly packed from the outside, and its few simple parts are skilfully made, properly fitted, and will stand the test of years.

One of its many superior points are the hinge bolts and priming valves, with which EVERY CAMERON PUMP of this pattern is equipped.

Skilled attendance is not needed as with many more complicated pumps, for a CAMERON is made right at the start and stays right.

> "We have had fifteen years' experience with your pumps, and will accept no other for shaft sinking purposes."
>
> S. SAUNDERS, SUPT.,
> The Teziutlan Copper Co.,
> Aire Libre, Puebla, Mexico.

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CAMERON PUMPS
Sent on Request to Interested Pump Users and Intending Purchasers

A. S. CAMERON STEAM PUMP WORKS

FOOT OF EAST TWENTY-THIRD STREET, NEW YORK

INDEX TO ADVERTISERS.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XV NOVEMBER, 1910 No. 11

THE SAND HOG

He's fifty inches round the chest,
His leather lungs are sound,
His heart must stand the air compressed
In caissons underground;
With pressure hammering his ears,
His shovel in his hand,
He works—in several atmospheres—
And burrows in the sand.

Beneath the "lock"
He spends his time;
He seeks bed-rock
Through silt and slime,
And blithely takes
His chances where
For us he makes
A Thoroughfare!

The job would never have a start
Without the Draftsman's wit;
The Ironworker does his part,
The Mason adds a bit;
They do their work—remember that—
But also please recall,
The Sand Hog certainly is at
The bottom of it all.

When he is through,
Right on his heel
May come the crew
With stone and steel;
But till he's done
They wait their day,
For he's the one
Who clears the way.

The Engineer says "Go ahead!"
The Sand Hog wiggles down
In tunnels through the riverbed
Or subways in the town;
Through quicksand, gravel, rock and mud—
With death itself to dare
From falling rock or sudden flood—
He digs a Thoroughfare.

When moisture seeps
Through chink and crack
And all that keeps
The water back
Is air—just air—
He doesn't shirk,
The job is there—
And that's his work.

Because he toils and sweats below,
In steam and dripping heat,
The tall steel buildings rise and throw
Their shadows on the street;
For tubes in which the millions ride
To do their work each day,
For bridges flung across the tide,
The Sand Hog clears the way!

—*Berton Braley, Saturday Evening Post.*

THE CONTAMINATION OF CITY AIR

By Dr. George A. Soper.

[The following is a portion of a valuable and highly interesting address by Dr. Soper before the Boston Society of Civil Engineers, printed in the Journal of the Association of Engineering Societies. The opening paragraphs are here omitted; another portion, which we think still more interesting, will be printed in our next issue.]

The changes of opinion with respect to the cause and prevention of disease which the new knowledge, especially of bacteriology, physiology and chemistry, has produced, have been revolutionary. The entire basis upon which the sanitation of cities should rest was changed

when it was discovered that infectious diseases could not originate in filth and foul odors, as had always been supposed, but were ascribable in every instance to some pre-existing case of disease, just as the existence of a grain of wheat is ascribable to some other grain of wheat which has gone before and served as seed.

It is interesting to note that in the progress of sanitary science nothing has occurred to shake the opinion that the air we breathe is by all means the most important single matter to which sanitarians can give attention. As a recent anti-tuberculosis campaign poster put it: "Man can do without food for three weeks, and without water for three days, but he cannot do without air for more than three minutes."

There is a singular difference between our requirements for air and our need of other life-sustaining elements. We are generally much less fastidious about the composition of our air than about the composition of our food and drink, and yet health and efficiency are profoundly affected by the quality of the 400 cu. ft. or so of air which we daily take into our lungs. Send your pale city man to the country and see the visible improvement in energy, spirit and strength which he at once experiences.

The evil effects of bad air are not so immediately apparent. They are generally hidden for so long that the victim comes to believe he is immune, or that the danger has been exaggerated. But eventually the price is paid.

Air, like water, is, in natural condition, pure. It is to man's use of it that the most harmful attributes which it sometimes possesses are due. So far as the essential gases are concerned, the atmosphere of the prairies is as pure as that of the sea, and the air of the marshes is as wholesome as that of the mountains. In the open there is as much oxygen in one place as in another. Much of the difference in chemical composition which seems to exist is due to differences of temperature and humidity, and the effect of various conditions acting agreeably or otherwise through the senses of sight and smell. The point most worth bearing in mind in considering this question is that under the natural conditions which exist in the free, open atmosphere of the country there is always enough oxygen for life and health, and rarely any other gases which can do either good or harm. It is the air of cities, and especially the air of inclosed spaces, that is likely to be contaminated.

It is doubtful whether ozone actually exists in the atmosphere. Sir William Ramsay has expressed the opinion that it does not exist. Yet the scientists of the Montsouris Observatory of Paris make determinations of what they consider to be ozone regularly, and we have in New York City, in Central Park, an observatory where Dr. Draper has been making what he considers to be ozone determinations for a long time. We have recently had ozone recommended as an air purifier. A few years ago, in the Paris subway, I saw an ozone machine, a machine for throwing ozone into the atmosphere in the hope of improving the condition of the air. Ozone is a curious form of oxygen which produces an opposite effect—at least, when fairly concentrated—to what one would expect of a healthful agent. It produces the symptoms of influenza, as I can testify, having experimented considerably with it in the laboratory in experiments to sterilize water. Professor Leeds, of Stevens Institute, had to give up experimenting with ozone entirely because of its unpleasant effects.

The air impurities which are worthy of notice do not belong to any one class or group of substances, as do the water impurities which affect health. Aerial contamination may be chemical, physical or microbic. By chemical impurities is meant chiefly the gaseous products of industrial works, compounds produced in the combustion of coal and illuminating gas. It is unnecessary to make extended mention of the effects of these gases, although the fact should be noted that carbon monoxide, a prominent ingredient of the gas which is produced when coal and other carbonaceous matters are burned with an insufficient supply of air, is a powerful poison, which not infrequently causes death in mines and elsewhere. Methane is the greatest danger of mines. It is produced when organic matter is decomposed in the absence of air and presence of water. Sewage septic tanks give it off, for example. Methane, like carbon dioxide, destroys life by diluting the oxygen present. There must be a large proportion of it to affect one seriously. It is explosive when mixed with about ten times its volume of air.

There is no gas known to science as sewer gas, the ghost which formerly went by that name and was supposed to creep with deadly

effect into dwelling houses through plumbing fixtures having been laid years ago. Sulphureted hydrogen, methane and carbon dioxide are often present in the air of sewers, as is the much more dangerous illuminating gas and gasolene vapor. These two have from time to time caused startling explosions in the sewerage systems of New York and other cities. The Metropolitan Sewerage Commission of New York, to which I have the honor to belong, has made a systematic inspection of the sewers of Manhattan Island in co-operation with the Department of Public Works, and one of the specifications which we made in that co-operation was that our men were not to be sent down in what is called the gasolene district.

Turning to gaseous impurities due to the presence of human beings, it is reassuring to know that air which has passed through the lungs possesses practically no poisonous properties of chemical composition in spite of the teachings to the opposite effect which are a favorite theme of text-books. The unpleasant odors are objectionable chiefly because they are unpleasant. Perhaps that statement should be qualified to this effect, that although every effort has been made by scientists for years to detect the presence of poisonous products of respiration, those efforts have been without success. Some years ago a number of men who became somewhat famous as a result of their researches came to the opposite opinion. They believed that gaseous poisons were produced by breathing air. But we know now that their technic was imperfect and that the animals that were experimented upon were poisoned otherwise than by products of respiration.

The air of an overcrowded and badly ventilated room is slightly lacking in oxygen, but the deficiency is generally not great and under ordinary circumstances is readily compensated for by an imperceptible acceleration in the rate of breathing. Accelerations of far greater extent than any which are likely to be produced by a deficiency of oxygen due to bad ventilation take place upon the slightest exertion in any atmosphere.

Air which has passed through the lungs is loaded with vapor and with carbon dioxide, but in view of the harmless nature of the latter gas its presence need not, under ordinary circumstances, be considered of great importance. The danger of chemical poisoning through breathing an atmosphere charged to the extent of one part of carbon dioxide in a thousand parts of air, which is the limit often set by law for factories and workshops, seems trivial when we consider the quantities of undiluted carbon dioxide which are taken into the system with tobacco smoke, beer, mineral waters and sparkling beverages generally. The sanitary significance of carbon dioxide lies in the index which it affords of the presence of other and more dangerous impurities of human origin. Tests of air for carbon dioxide are like tests of water for chlorine,—they furnish a clew to the presence or absence of harmful microbes.

The free atmosphere, that is, the air out of doors, possesses a sensibly beneficial quality which has baffled the keenest investigators to explain and it cannot be produced artificially. Some years ago a number of scientists were appointed to examine the air of the meeting rooms of the Houses of Parliament. They were given liberty to choose the most refined methods of analysis, and were instructed to determine why it was that the ventilation of those rooms was not satisfactory. The scientists reported that the cause of the unsatisfactory condition of the air could not be determined, but that there was a perceptible lack of freshness about the atmosphere. That freshness, the quality which we all have noticed in going out of doors, can never be obtained in a completely inclosed room. It is at once the ambition and the despair of ventilating experts to bring about such a condition. It seems to be impossible even to account for it.

The microbic poisons which air sometimes contains are by all means the most directly dangerous impurities which are likely to be present. They are the inciting cause of tuberculosis and pneumonia, which, together, produce more deaths than any other disease or group of diseases to which man is liable. The forms of sickness which are transmissible by air include nearly every contagious and infectious disease which occurs in our northern climate, except the disease which has the distinction of being named bad air, or malaria.

How disease germs get into the air, how long they survive and how they fasten their infinitesimal personalities upon their unwilling hosts, is a subject of fascinating interest, but one which we can notice here only in the

briefest terms. Everything is not yet known about this subject, by any means. A few facts, readily understood, are worth keeping in mind for the sake of the simple precautions to which they point.

The sputum of persons suffering from respiratory affections contains the infectious germs of their diseases in large numbers, and it is desirable that this material shall at once be rendered inert by disinfection, preferably by burning, in order that its poisonous nature shall be destroyed. In a dried state these germs may persist for weeks, although it is doubtless the fate of most of them to perish under such natural influences as desiccation and sunlight within a brief time.

It seems unnecessary to mention the fact that the sputum in tuberculosis and in pneumonia may remain capable of producing tuberculosis and pneumonia when inhaled by persons who are in a receptive condition. And yet that point has been disputed. Evidently the crusades which the tuberculosis experts have been making have not converted everybody. In experiments which I have made I have found that the germ of pneumonia may remain viable for twenty-one days when kept indoors, and be destroyed out of doors, in the streets, within four or five days.

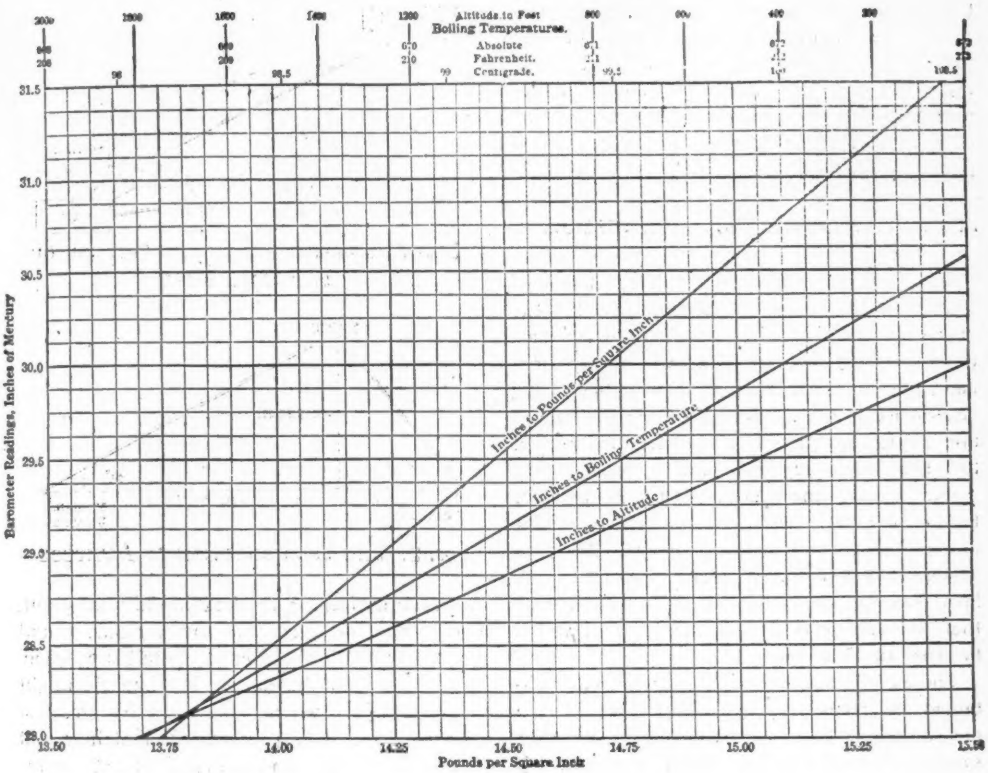
It is not considered, however, that tuberculosis and pneumonia are most often contracted by breathing germs which have been dried and raised from the floor or the street in the form of dust. Hygienists are coming to the opinion that the destruction of most species of pathogenic bacteria proceeds rapidly outside of the favorable environment of the body, and that the transmission of disease germs from person to person generally takes place in ways which are comparatively short and direct. This view is reasonable and reassuring and goes far to compensate for the disquieting results of some recent investigations, which show that bacteria may be projected into the air from wet surfaces and under favorable conditions of temperature and moisture retain their normal characteristics for considerable periods of time. For example, sewer air has recently been found to, at times, contain bacteria which have become separated from the sewage by splashing, by the bursting of bubbles and by the alternate wetting and drying of exposed surfaces.

More important to most of us is the danger of germs thrown into the atmosphere by persons in the acts of coughing, sneezing and speaking. It has been found that in these natural and apparently innocent performances minute particles of saliva are ejected in great number, and that these droplets often contain bacteria. The moisture soon evaporates, leaving the germs free to keep afloat in air currents or gradually subside like motes of dust. Cough spray, as this fusillade of germs is called, may be highly poisonous, for not only are the bacteria which it contains thrown into the air in a perfectly fresh and virile condition, but they are relatively concentrated. Fortunate it is that so few of the countless species of bacteria which exist are capable of causing disease, yet the fact that the mouth is the normal habitat of at least a half dozen kinds of germs, and is sometimes the abiding place of diphtheria bacilli and other pathogenic species, considerably modifies the comfort which we can take in this reflection.

AMERICAN SUPREMACY IN COAL MINING

From figures on the world's coal supply, in a recent British publication, the Bureau of Manufactures of the Department of Commerce and Labor has compiled statistics, showing that the United States, with 690,438 persons employed in mining coal in 1908, produced 126,562,000 tons of coal more than were produced by 966,264 persons similarly employed in the United Kingdom, and that the production of coal in the United States amounted to 538 tons per person employed, as against 271 tons produced per person in the United Kingdom. Based upon reports of 1908 and 1909, the total production of coal in the United Kingdom, the United States, Russia, Sweden, Germany, Belgium, France, Spain, Austria, Hungary, and Japan for 1909 was estimated as 958,674,000 tons, with a total value at the pit of $1,854,323,893, and an average value per ton of $1.93. The number of persons employed in producing the coal was 3,172,110, and the average number of tons produced per person 294.

In regard to the coal consumption of the several countries the report says: The consumption of coal in the United States is more than twice as great as that in any other country, and nearly equals the combined consumption of the United Kingdom, Germany, France, and Belgium, and is actually greater per capita than in the United Kingdom.



A BAROMETER CHART

The accompanying chart, originally contributed to the page of *Power and the Engineer* by G. A. Glick, is designed to facilitate the transformation of barometer readings in inches of mercury into equivalent pounds per square inch, to show the corresponding boiling temperature of water at any barometer reading and to find the altitude corresponding to any barometer reading. The chart is plotted only between 28 and 31.5 inches of mercury, for the reason that the larger number of calculations come within this range, and the small range permits considerable accuracy, that otherwise would not be obtainable. The scales used are all rather fine and this will permit close readings, which are liable to be more accurate than can be obtained on a slide rule. The spacing for the mercury readings is in eighths of an inch, which unfortunately does not correspond very well with the decimal figuring, but need not be misleading.

A few constants are given to permit calculations beyond the limits of the chart. With regard to altitude it may be said that, as a rough approximation, the pressure of the atmosphere decreases one-half pound per square inch for every 1,000 feet of ascent, or in descending toward the center of the earth the barometer readings increase by 1 inch of mercury for every 900 feet drop. To change inches of mercury to pounds per square inch, the well known rule of multiplying the reading in inches by 0.4908 gives the corresponding pressure in pounds per square inch. Roughly speaking, pure water will boil at 1 degree Fahrenheit less for every 550 feet ascension up to an elevation of one mile, after which the increment becomes 560 feet.

The chart can be used interchangeably, that is, pounds per square inch can be used instead of inches of mercury to find the corresponding altitude and boiling point, or even the barometer reading, if it is desired. In this case all the values would have to be reduced to inches of mercury as a common standard. For example: Suppose the barometer reads 29.925 inches of mercury. Looking on the chart at

this reading we find the corresponding pressure to be 14.68 pounds per square inch. The altitude corresponding to this barometer reading is 70 feet, and water will boil at 211.87 degrees Fahrenheit. Care must be taken that each reading is taken from the proper curve plotted for that condition.

MEASURING AEROPLANE ALTITUDES

By Augustus Post.*

To obtain the altitude of Mr. Brookins' (Wright) aeroplane at Atlantic City, for the National Council of the Aero Club of America the first thing that was done was to lay off a base line of sufficient length so that the angles observed through the surveyors' transits would not be too great when the aviator crossed this line at his highest point.

Such a base line was laid out running from the outer end of the Atlantic City steel pier to a point on the board walk, near Tallahassee avenue, about two miles and a half distant. A boat was anchored midway along this line so that the aviator could tell the point at which to cross the base line.

The exact length of this base, which was obtained by triangulation and the use of the measurements of the Atlantic City monument system, was found to be 13,394.29 feet, which is undoubtedly correct within a narrow margin.

Two surveyor's transits were set up, one at each end of this line as a base; each telescope was pointed toward the other station and clamped in that vertical plane, although movable in altitude in that plane. The question might be asked as to why it was necessary to have the telescopes clamped in the line between the two stations, thereby requiring the aviator to cross this line when at his highest point, if his highest altitude was to be recorded, in view of the fact that an engineer's transit will measure angles in azimuth as well as in altitude. John W. Hackney, of the firm of Ashmead & Hackney, civil engineers, of Atlantic City, under whose direction the engineering problems were worked out, has ably answered this question in his official report as follows:

"This might possibly be the best method, i. e., to move the telescopes in azimuth also, if

*Official recorder for the National Council of the Aero Club of America.

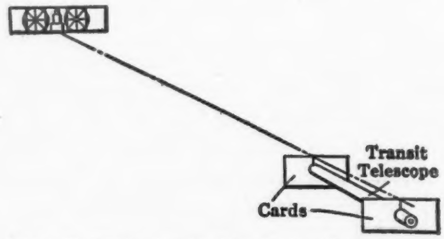


Fig. 1. Cards for Sighting Outside of Telescope Field

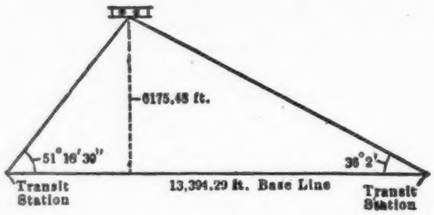


Fig. 2. The Triangulation of Altitude

the aviator, having reached his highest point, could stop his aeroplane for a moment and then signal both observers to note his position. But this cannot be done. He himself might not know just when he was at his greatest elevation, and it is quite certain that he could not momentarily stop his machine; but assuming that he did know and did give a signal, we must still assume, since he cannot remain still, that both observers have the aeroplane within the telescopic field of view at the moment the signal is given. This means that each telescope must be kept continuously upon the aeroplane by moving it steadily and continuously both in altitude and azimuth. This motion, unless the object is very far off, may be too rapid for slow-motion tangent screws, and in any event the range of continuous motion by the tangent screws is quite limited. An actual attempt will quickly convince the observer that such a method is impracticable.

"The same reasoning will show that the firing of a pistol by some observer as a signal when the highest altitude has been reached, and when observations are to be taken, or the making of simultaneous observations at stated moments by reference to synchronized watches, is impracticable, since both methods presume that the object is within the field of view at the precise moment the signal, or order to observe, is given.

"The establishment of a vertical plane pass-

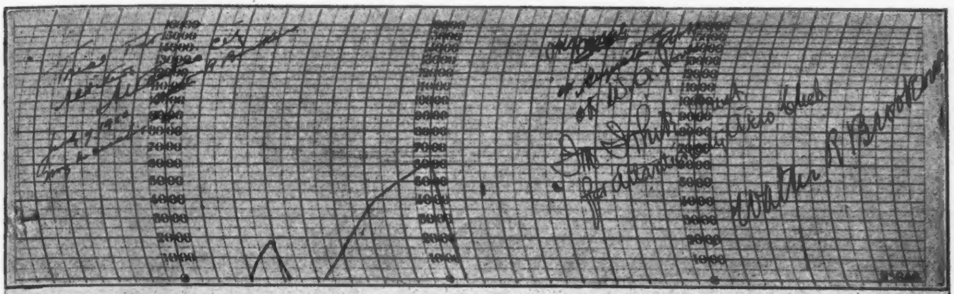


FIG. 3. FAC-SIMILE OF RECORD OF ALTITUDE REACHED IN AEROPLANE FLIGHT BY WALTER R. BROOKINS, ESTABLISHING THE WORLD'S RECORD. CHART TRACED BY RECORDING BAROMETER

ing through the instrument stations simplifies the problem, if the aviator passes through it approximately at right angles thereto, since the observations which must be made by both observers while the object is in the field of view must be practically simultaneous, which is, of course, a necessary condition.

"The work of the observer is reduced to the maintenance of his instrument in proper level, and the single observation of altitude. This, so far as the pointing is concerned, is quite a problem, since the telescopic field is small, and unless the observer has his telescope at the correct altitude he may, and probably will, miss the transit of the object altogether. To avoid this, range sights were attached to the telescope of each instrument. These were rectangular strips of stiff cardboard 3½x8 inches, two for each instrument.

"In the center of each card was cut out a circular hole; one card was slipped over the object end of the telescope, removing the sunshade for this purpose and then replacing it, and the other was fitted to the eye end. These cards were leveled by ranging with the horizon. A black line was ruled on each card midway between the ends to act as a sight for the telescope. A plane resting upon the top edges of the two cards would be parallel with the horizontal axis of the telescope.

"The telescope was moved in altitude so that the upper edges of the two strips of cardboard were in range of the aeroplane. This range was closely maintained by moving the telescope up and down with the left hand, while the right hand held the clamping screw. The eye was kept likewise in range with the aeroplane and the vertical black line on the card nearest the eye. Just before this line and the line on the object end of the telescope came into range, the telescope was clamped, the right hand was quickly transferred to the tangent screw and the eye to the telescope.

"If the aeroplane crosses the line at a reasonable distance from the observer, and in a direction at right angles to the line, there is no difficulty in getting an accurate sight; but if he is too near, or the angle is too acute, the observer may miss the transit altogether, since the altitude of the aeroplane is changing with great rapidity."

The angles read at the moment of crossing the base line on the particular occasion when

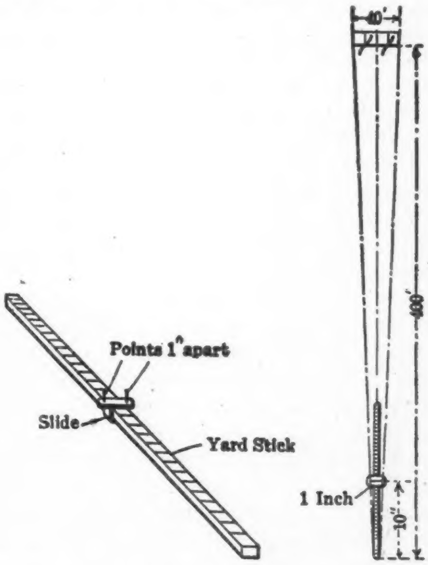


FIG. 4. YARDSTICK METHOD USED BY WRIGHT BROTHERS

Mr. Brookins was at his highest point were 51 degrees 18 minutes 30 seconds at the steel-pier station and 36 degrees 2 minutes at the other station. These angles being known, with a known base it was possible to figure out the altitude, which was 6,175.48 feet above mean sea level.

In this case the aeroplane itself was fitted with a Richards recording barometer, which registered automatically a height of 6,200 feet, as seen by a chart which is reproduced. This is a very good check on the surveyors' calculation, and shows how the ordinary balloon practice may be of value to the aeroplanist.

The Wrights themselves use a very simple and rough, but remarkably accurate, method of obtaining altitude. A man lies on the ground, on his back, and sights along a yard stick held directly above his eye. There is a slide on this stick, with two points just one inch apart. When the aeroplane is directly over the observer, this slide is moved along the yard stick until the points are in line with each end of the aeroplane, which is known to be 40 ft. wide.

If at this time the points on the slide are 10 inches from the observer's eye we have an equation which would be: 1 inch is to 10 inches as 40 feet is to x feet, or $x = 400$ feet.

Altitude measurements will be of the utmost importance in finding the range of an aeroplane in time of war, and to catch sight of a moving object is very difficult with instruments designed for fixed objects. Great angles may be read by means of solar transits, or mountain theodolites, and instruments fitted with prismatic eyepieces, but these are not easily obtainable.

One old sailor even calculated that Brookins was at an altitude of about 6,200 feet, by means of his antique quadrant, and said he could come closer if he knew just how wide the aeroplane was.—*American Machinist.*

PNEUMATIC TOOL EXPERIENCES

The folowing stories of experience were called out at the summer meeting of the Railway Tool Foremen's Association:

J. T. Fuhrman: I want to tell of a little experience. I was to do some repairs on the line. We repaired all of the air hammers, and we did the work as good as possible—just as we do in St. Paul, and we have very little trouble. There was one instance that was reported to the office; the hammer would not work any more, it was too weak. I examined the hammer and found it was all dry; the piston was gound off so it was loose. The man who repaired the hammer did not lubricate it; the piston stuck and he took the piston to the emery wheel and ground the piston; the air blew through and he lost the effect of the stroke. That shows what will happen when a man does not understand how to handle a hammer, and the toolman gets the blame for it. The care of the hammer is just as important as the repair of the hammer.

A. W. Meitz: I think it is about three weeks ago; we had a No. 90 hammer that suddenly gave out and would not work. A man took it apart and it hit a blow, but not hard enough. We did not see anything wrong, and we opened a little valve. We found the nut and the safety plug, but no little valve. We did not know what had become of it. The hammer was together solid, the lock nut was in four pieces. I think nobody could take that out and replace it again, because it would be a hard matter to bring that back in there. We came to the conclusion that the valve broke and went in to the piston. We repaired that and it has been running ever since, and we have had no trouble with it. It is a mistake to take a pneumatic tool out of a tool room and run it as long as it will run. Look out that you get your tools back once a week at least, if not every night. It isn't the fault of the manufacturer; it is always the use of the tool that causes the trouble.

J. H. Simons: I think we have a great deal of trouble with the pneumatic tools owing to the fact that the men who are using the tools never knew anything about machinery during their natural life. I have been a boiler maker all my life. A boiler maker in a boiler shop never has anything to work with but a solid piece of iron in the form of a sledge—something that is solid and indestructible, and he does not appreciate the fact that a hammer or drill needs some oil. We never had to put any oil on the riveting hammers. All the oil needed was inside of them. They seem to look at the pneumatic tool in the same light to-day.

Another class is the "Hunkey laborer." He never did know anything at all. I had to go to work when I was 14 years old and have worked twenty-four years. I have had charge of railroad shops and contract shops, and when I used to get hold of a pneumatic tool I never stopped to consider that it needed anything

more than the other hammer, and about all that got was a little grease. It is up to the foreman to educate the men so they will know how to keep these tools clean. I have seen them take a hammer and knock a chip off. They seemed to think it ought to run as long as they brought it up. The machinist who knows how to use tools will oil them once in a while, but the boiler maker squirts some oil on the end of the twist drill when he sees the smoke come from it. I used to slam a tool down and tell them it wouldn't work, but I know a little bit different now. The men have to be educated to keep the tools clean in order to keep them running. If you do that, you will have little trouble with tools.

Secretary Harroun: I want to relate a little experience with the boiler makers. They don't mind being called mules; they like it. I believe the secret of the whole thing is that they do not like to use the hammer. They may become better reconciled to the use of it than when they first started to use pneumatic hammers. I at one time had some men prossering flues. They were breaking as many by expanding the flues as I could make, and I thought I would try to stop it. I got a No. 90 hammer and I made a taper pin that would just stick out and that was all. I took it to the boiler maker who was expanding flues and asked him to try it. "Not on your life; do you think I am a mule or an elephant. If they want me to rivet they will have to put a derrick up to hold it, and a man to operate the derrick." It occurred to me that there was something radically wrong that they did not care to use these things; but I have since been told by boiler makers who talked to me in apparent candor that they liked them; that they would not go back to the old way of riveting under any circumstances.

In regard to the care of the tools: The boiler maker is very differently situated from the machinist. He has to contend with more difficulties. He has to work in the boiler front end or in the fire-box, where the light is poor. If he throws the hammer down and breaks the trigger, he really isn't so much to blame. I have more charity for the boiler maker than I have for the machinist, because the machinist is outside. But the boiler maker who will take a hammer, and when you have put on one strainer after another on the end of it and doesn't blow his hose out and the hammer won't work and he knocks a hole through the strainer to be sure he is getting lots of air; he is the fellow I don't like.

Speaking about motors, when a motor leaves my department I know that it is all right. If it is sent to Kansas City, or any outlying point, we do the repairs for all the points. One day last week I had a motor come in. There was a letter addressed to Peter Maher, superintendent of motive power, which said in substance: "This motor was sent on train so and so to Bloomington for repairs; sent back to all appearances without any repairs being made on it. The motor doesn't work any better now than it did before. Kindly take this matter up with your tool foreman and see if that is the way they handle their business." Or something to that effect. I was satisfied in my own mind that the motor was all right because the man that I have on air tests had made the tests on all those things before it left the shop. I knew there must be something wrong out there with the air hose or pressure of air. I took the motor which was lying on the floor and I said to a man: "Try that motor." He put the air on it. I told him to put in a half inch twist drill, in the end of the socket put a piece of iron and put the pressure on it. That is the only way I do the testing. He drilled in a very short time through a one-half inch piece. I immediately went to my desk and I wrote a letter stating that to my mind it would be well to place some manner of instructions as to the care of pneumatic tools in these outlying shops. To have apparently intelligent men jump at conclusions and send letters of that character which reflected upon my department was not very pleasant. I do not know what they did. The machine went back and I have heard nothing from it. This is the condition the tool men are up against. They will place a tool in service or couple it up to a hose, and never stop to think that there is a possible chance for the hose to become clogged up, or that they ought to blow a hose up before coupling up to blow the scale and dust out. You may talk as I have often done to boiler maker foremen to do so and so and save a lot of trouble, but they say, "I will take it up." But the railroad goes on just the same, with total indifference, but the time lost by bad management of tools reflects back to the tool room foreman.

E. J. McKernan: I would like to give a little

experience. When Dr. Derby was handling the tool room there was a motor sent in from Texas from a main shop on the Gulf Line, a No. 5 Little Giant wood boring machine. The motor was bone dry. He called my attention to it. The machinists in a good many cases are as bad as the boiler makers. I have been a machinist and had some experience in boiler work too, but machinists nowadays are severe. They throw a motor down from the top of a locomotive and it caves in the cylinders. In our main shop they have a kind of sub-tool room where all the air hammers, hose and various boiler maker's tools are kept, because the boiler shop is an off-set of the main erecting shop, and we do not want them to cover any more ground than necesary to get the tools and return them. The man in charge of this tool room happens to be a boiler maker's handy man. He has a vat that is filled with coal oil that is turned off in the evening on account of the insurance, and he soaks all the hammers in that. But before each motor or hammer is turned out it is thoroughly oiled, regardless of how many times a day. No. 1 is turned out and Jones has it an hour or two; then it gets oiled again, but where they are out in the shop they do not get oiled until evening. We have a man go round and oil them up. The tool man in the boiler shop has a "shot gun" there and gives them an injection twice a day. It has prolonged the life of hammers two to one. We have motors to run hot, but we cannot get around that.

On Saturday night we have an air man who goes over all the motors, looks at the mechanism of them and oils them regardless of the man downstairs in the supply department. We have cut down our air tool expense quite a bit and it saves kicks to the manufacturers we buy from, because it isn't their fault. We know just exactly what horse power they are and when a man sends one in and wants it tested we stick it on the test rack. If it only shows 50 pounds, we realize it has only one-half the power it should have.

Natural gas is used for fuel on the locomotives of the Texas, Arkansas and Louisiana Ry. The gas is carried in a tank on the tender, sufficient tank capacity being provided for six hours' run. The road has two locomotives and one car, and is credited with eight miles of track.

AN ELECTRIC GAS, AIR OR STEAM METER*

By Prof. Carl C. Thomas, Madison, Wis

The operation of this meter depends upon the principle of adding electrically a known quantity of heat to the gas and determining the rate of flow by the rise in temperature of the gas between inlet and outlet of the meter. This principle lends itself to the operation of a meter possessing the following characteristics:

a. There are no moving parts inside the meter or in contact with the gas.

b. The accuracy of the meter and its sensitiveness are independent of the rate of flow of the gas, and of fluctuations in pressure and temperature.

c. The meter may be used to measure gas at high pressure as well as at low pressure, and is independent of small fluctuations in pressure, such as those in the discharge from an air compressor or in the suction of a gas engine.

d. The meter produces a continuous autographic record showing the rate of flow and its variations.

e. Meters of comparatively very small size have very large capacity.

f. The meter may be opened for inspection, for blowing out accumulated matter with an air blast, or for washing with gasolene, and it can be dismantled to any extent desired without interfering with the operation of the plant.

Fig. 1 shows the meter as constructed for air or gas measurement. It consists essentially of two parts: first, the measuring element *A*, Figs. 1, 2 and 3, through which all the gas passes when the meter is in operation; and second, a by-pass, *B*, Fig. 1, so arranged that the meter can be readily cut off from the gas main by operation of the valves *C*, when it is desired to operate without the meter for the purpose of inspecting or cleaning out, or to cut the meter out altogether for any reason.

The meter consists of an electric heater, *D*, Figs. 1 and 3, formed of suitable resistance material disposed across the gas passage in such a way as to impart heat uniformly and at a regular rate to the gas passing through the meter. The temperature of the gas is thus

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*Condensed from Transactions of the American Society of Mechanical Engineers.

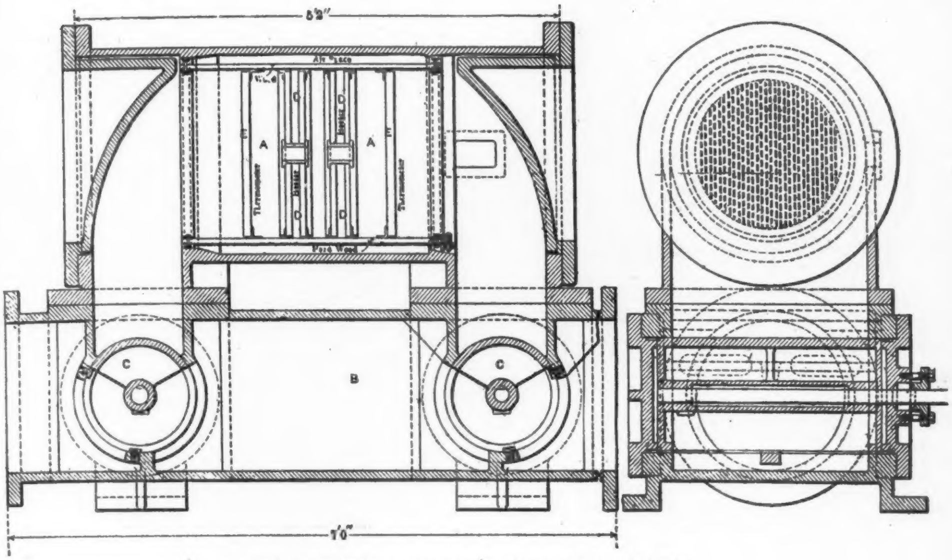


FIG. 1. SECTIONS OF ELECTRIC, GAS OR AIR METER.

raised from that at entrance to some higher exit temperature, and the rise of temperature is measured and autographically recorded by means of the two electrical resistance thermometers *E*; Figs. 1 and 3, on the two sides of the heater.

These thermometers consist of wire wound upon vertical tubes so disposed as to come in contact with all the gas passing through the meter, thereby indicating the average temperature over the cross section of the gas passage. The fifteen tubes shown at the right of Fig. 1, and also shown in Fig. 3 and Fig. 4, extending in a vertical direction over the cross-section of the meter, support the resistance wire of the thermometers so as to afford a rugged construction. These thermometers are connected to a recorder (Fig. 4), which draws a line on a chart and thus indicates the difference of temperature between the two thermometers.

5. A typical diagram is shown in Fig. 5. This diagram represents a gas flow of from 90,000 to 85,000 cu. ft. per hr., taken during a portion of the day when the fluctuation in flow is small, but nevertheless continuous.

The diagram in Fig. 6 was made during a period in which the flow varied extensively, the smallest amount recorded being about 17,000 cu. ft. per hr., increasing to 45,000, then to 62,000, to 75,000, the record ending at a flow of about 32,000.

The record in Fig. 5 was made with a temperature difference of about 4 deg. Fahr. between the two thermometers, and an energy input of approximately 2 kw. The energy input when the record in Fig. 6 was made was approximately 1.15 kw. Fig. 5 is a typical record for a meter of normal capacity of 100,-

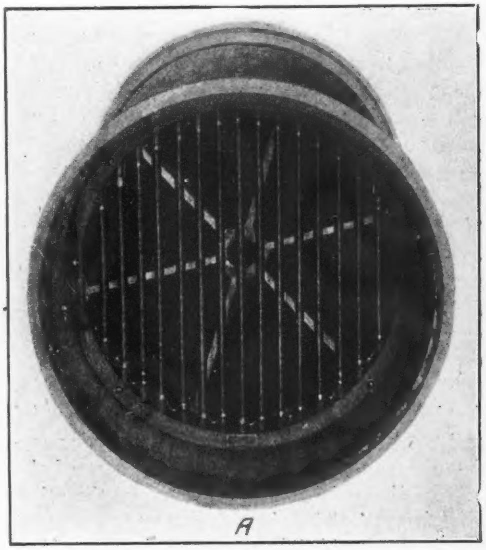


FIG. 1. HEATER UNIT AND RESISTANCE THERMOMETER.

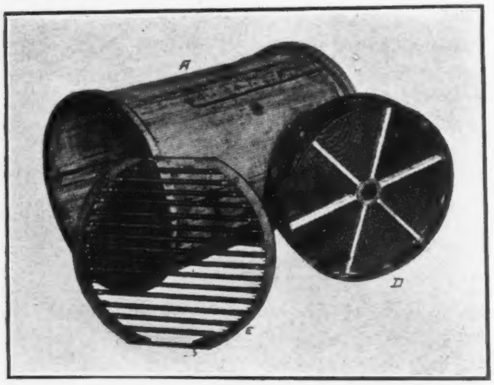


FIG. 3. SHOWING CONSTRUCTION DETAILS.

000 cu. ft. per hr., with an electric input of 2 kw.

The principle underlying the measurement of gas by this means is as follows: If gas is flowing through the heater at a given uniform and constant rate, and if heat is being supplied electrically, and imparted to the gas at a constant rate, a certain definite rise of temperature will be produced in the gas during its passage between the two thermometers and through the heater, and this constant difference of temperature will be maintained so long as the amount of gas passing per unit of time is constant. But if the quantity of gas passing per unit of time diminishes, the heat supplied at the same constant rate as before will raise the temperature of the gas by a greater amount than was the case when a larger quantity of gas was flowing and absorbing the energy liberated by the heater. Conversely, if the rate of flow increases, the energy being supplied to the heater and delivered to the gas will not be able to raise the temperature by as great an amount as when the rate of flow was less. The temperature difference produced by a known input of electrical energy thus forms a measure of the quantity of gas flowing through the meter.

The meters have been calibrated with illuminating gas and with air. A certain amount of water vapor is carried with the gas or air passing the meter. This vapor forms part of the gas or air, and is heated just as are the other constituents. The rise of temperature caused by the heat added in the meter is only a few degrees, and consequently the water vapor does not experience a change of state. The temperature of the metal forming the electric heater rises only 15 or 20 deg. fahr. above the temperature of the gas. The question of latent heat of vaporization of the water vapor therefore does not enter into the considerations underlying measurement of the gas.

While calibration of the meters under actual conditions of service is depended upon to obtain quantitative results, yet these meters are of such a nature that the quantity of gas or air passing through them can be very closely calculated from a knowledge of the energy input and the specific heat of gas or air. This fact, that the quantity of flow can be quite

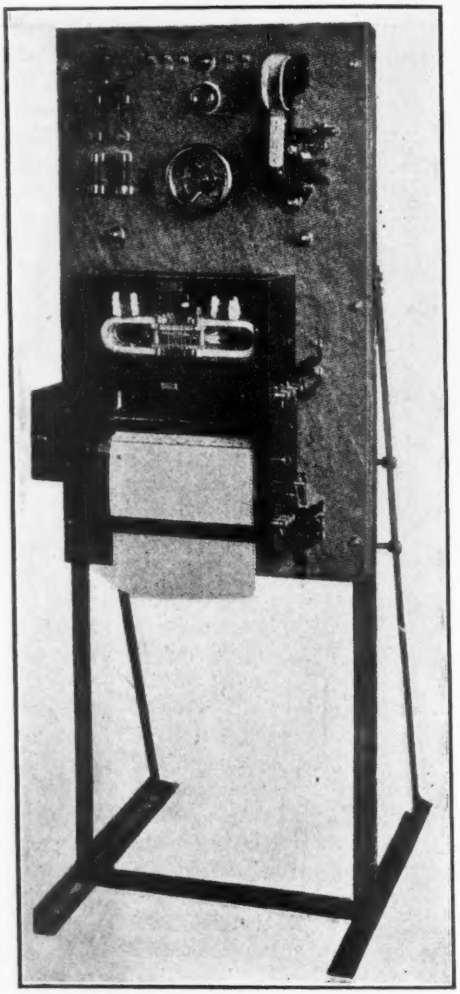


FIG. 4. RECORDING AND OPERATING INSTRUMENT.

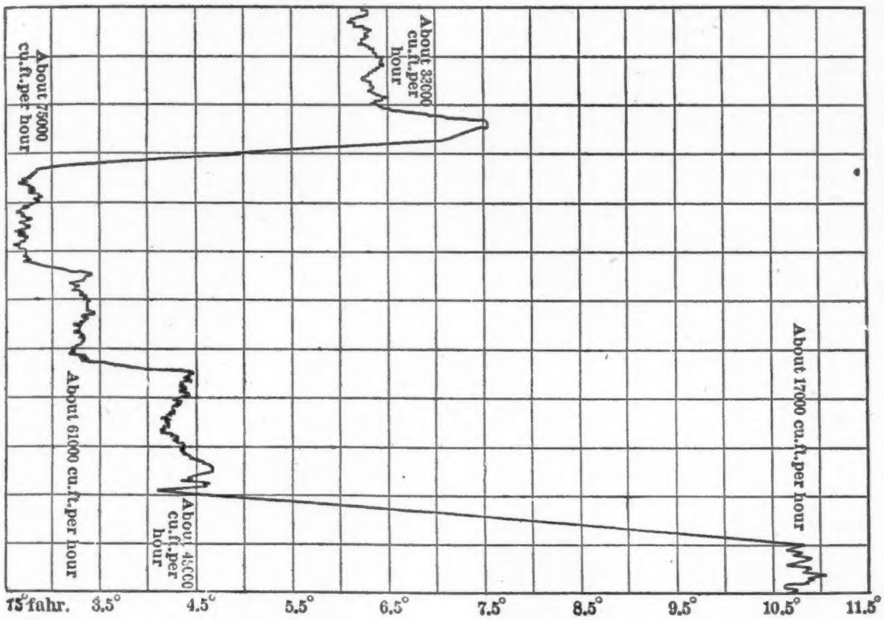


FIG. 6. AUTOGRAPH RECORD.

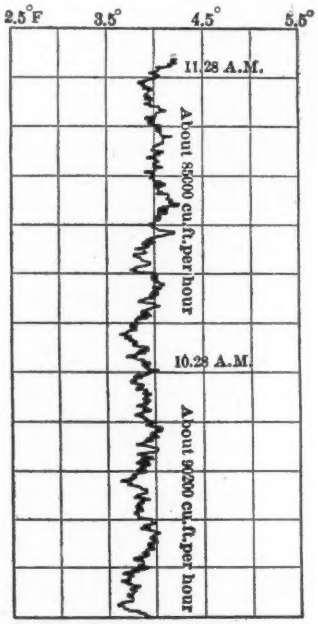


FIG. 5 TYPICAL DIAGRAM.

closely calculated, independently of a calibration curve, makes it possible to check the accuracy of the readings obtained.

The development of this meter is a result of experiments which the writer has been making for some years to determine the specific heat of gases by heating them electrically. The performance of a properly constructed heater for this purpose proved to be so entirely regular that it was apparent that the quantity of gas flowing through it could be very accurately measured by the method now used in these meters. The problem is thus the reverse of the problem of determining specific heat by measurement of the electrical energy necessary to heat the gas. It will be seen by reference to Fig. 1 that the whole process of heating the gas and of measuring the difference of temperature between inlet and outlet, is accomplished in a relatively small space which is well insulated so far as heat losses are concerned, since the heater and thermometers are contained in a casing made of hardwood strips and separated from the metallic walls of the meter by an air space.

The accuracy of these meters is not affected by changes in pressure of the gas or air, since the unit of measurement is that of weight rather than of volume; that is, the meter takes cognizance of the specific gravity, or the amount of "stuff" in a given volume of the gas.

Also variation of temperature of the incoming gas does not affect the accuracy, because it is a difference of temperature, rather than a fixed temperature, upon which the measurement depends. The meter can be used for gas or air at either high or low pressure, and at either high or low temperature, provided the materials used in construction are suited to the conditions.

This method of measuring gas seems especially useful in connection with engines operated by gas from producers, blast furnaces, etc., and in measuring the discharge of gas or air from compressors, because the small and rapid periodic fluctuations of pressure, due to the suction of gas engines or to the discharge from compressors, do not interfere with the steady action of the thermometers. The time lag of the latter is sufficient to smooth out the curve of temperature variation, or of watts input, as the case may be, and true average results are thus indicated.

The temperature difference employed when operating with a constant difference, is approximately 5 deg. fahr. When a curve of temperature difference is employed, the temperature rise is from 4 to 5 deg. fahr. when the normal maximum amount of gas is flowing. This difference may be increased to 10 or 12 deg. when the rate of flow is greatly diminished, and at 100 per cent. overload the temperature difference is from 2 to 2½ deg. On the autographic record one inch represents a temperature difference of one degree. The thermometers and recording device are such as to render the records accurate within 1 per cent. The minute fluctuations shown by the curves on Fig. 5 and Fig. 6 are produced by the constantly varying rate of flow in the gas mains. These can be "damped out" to any extent desired. The apparatus with which this record was taken was purposely made sensitive to minute fluctuations.

The electrical energy required to operate the meters is approximately 1 kw. per 50,000 cu. ft. hourly capacity. The curves shown in Fig. 6 represent variations of from 17,000 to 75,000 cu. ft. per hr., and were made with an energy input of approximately 1.15 kw. To provide for more gas and still have the record lie conveniently on the paper, it is only necessary to increase the energy input by manipulation of the rheostat hand-wheel on the switchboard.

USE AND ABUSE OF MI N I VENTILATION*

Probably the oldest book on mining is by Agricola, in which there is a cut showing a man at the top of a shaft using a pair of bellows to send air to the men in the pit. As mines became deeper fire-damp was encountered, and then two openings were made into the mine in order to take advantage of natural ventilation. This is based on a column of cool, heavy air sinking down a mine-shaft, thereby forcing up another shaft a lighter body of heated air from inside the mine. This system of ventilation answered until the mines became so extensive that sufficient air could not be circulated to dilute the noxious or inflammable gases given off in the mines.

At first wooden chimneys were built over the up-cast to furnish a longer column of heated air, but such make-shifts could only afford temporary relief and were succeeded by fire-baskets placed near the bottom of the up-cast. These were a great aid until the extension of the mine caused a drag which was beyond their capacity to cope with. When this occurred furnaces were constructed in the mine, which used the up-cast as a chimney. Furnaces could be made sufficiently large to cope with almost any desired quantity of air, but they were considered dangerous in more ways than one. It is doubtful if one ever set the gas in a mine on fire, although they may have caused a fire in the shaft, or set the coal in the mine on fire through faulty construction.

To overcome the disadvantages of the furnace, attention was turned to mechanical ventilators. Either Bryams or Stranves devised a mammoth pump which had a piston and moved back and forth. This clumsy affair was not generally adopted, but Scheet's and Guibal fans came into use almost universally. The Guibal fan, on account of its sliding shutter and waste chimney, was the more favored, and is used largely to-day. Since then several other fans, including the Cappell and Sorroco, have been introduced.

The object of mine ventilation is to furnish fresh air to dilute the mine gases given off by the coal, men, mules, lights and oxidation. If

*From an address by Eugene B. Wilson before the Scranton Y. M. C. A. Mining Institute.

a mine gives off fire-damp, the rule is to furnish 50 cubic feet of air per minute for every ton of coal mined in twenty-four hours; and 150 cubic feet of air per minute should be supplied for every man. in the mine, irrespective of animals. Roughly, this would require 300,000 cubic feet per minute for 800 men producing 3,200 tons of coal daily, or 375 cubic feet per man per minute. This tonnage and number of men is unusual inside one mine, and while the quantity of air does no harm in an anthracite mine, it may spell disaster in a bituminous mine.

Gaseous mines must have large airways, for the reason that a larger volume of air can be passed with less speed through large than through small airways. If one imagines that all of the air is not passing through the mine, but through an orifice in a thin plate, then the equivalent orifice for any mine would be the aperture in that plate of an area such that a resistance would be offered to the air equal in amount to that caused by the mine workings.

Even with large areas to the airways, the air must be split and directed to the various workings in order that:

1—Each split will receive its quota of air.

2—The air may be regulated to supply the requirements of the men and the workings.

3—The friction of the air current may be reduced.

4—That the fresh air need not travel from one working to another, and so become impure before it reaches those in the last workings through which it travels.

It makes considerable difference whether the air is split properly—that is, properly distributed. There must be no short-circuiting. Air stoppings, overcasts, regulators and doors must be properly proportioned and kept in perfect repair. When it is necessary to drive ahead of the air the brattice or air boxes must be properly arranged, and under such conditions it is possible to work in safety in most mines.

Where sufficient gas occurs to call a mine gaseous more safety precautions are adopted and only safety lamps are used. If open lamps are permitted at all, it is only a question of time when they will pass into the danger zone and cause trouble. In such mines too much dependence is placed on the ventilation, which, up to the time of the accident, has proved sufficient to dilute all gas.

Ordinarily, one cannot have too much air, but it would seem that in coal mines such a matter is possible. In order to make this statement clear let us review three fatal explosions that have occurred in this valley in the last three months.

It frequently happens in anthracite mining that more gas will be given off from a face at one time than at another. There is no telling when this will occur, as it may come from a blast, a drill-hole, a fall of rock, or other cause. This increased flow of gas may cause a slight explosion, which, being local, is not considered more than an every-day occurrence. In one such case there was a local explosion, which seemed to have been slight in its effects. The men working in their rooms were not disturbed by it, but were told to leave.

Instead of doing so at once, they leisurely gathered up their coats, buckets and tools, and reached the gangway just in time to walk into the after-damp. This was where too much dependence was placed on the ventilation; but it teaches the lesson that where one is in the return air-course the only sure way to safety is to get out of it, whether the explosion is violent or insignificant.

It takes only a short time for one per cent. of carbon monoxide to kill a person; and there is almost sure to be that much in the after-damp of any explosion. There should not be any dependence placed on an air-current after an explosion, because the quantity of after-damp cannot be measured, and because the explosion may have disarranged the otherwise good circulation.

Not a long time after the above explosion another occurred, with fatal results. In this case a door was broken in such a manner as to allow a large part of the air that was intended to be sent up the heading to short-circuit. The working place was known to contain gas, but the men continued at work for over a day after the door was broken. Gradually the gas accumulated until it reached the explosive stage, and then several men lost their lives. Here again too much dependence was placed on the air; or, it might be said that the ventilation was abused.

The lesson to be drawn in this case is summed up in the phrase: "Nothing should be taken for granted where gas is given off." With

a good ventilating current and plenty of air properly directed we can only imagine a person to be over-confident who will work in the place where this accident occurred.

Only a few weeks ago another accident occurred where several capable miners lost their lives through some defect in the ventilating current or a sudden increase of gas. In this particular case the men were warned against using open lights, but after the accident they were found dead with safety-lamps in their pockets. Everything in this case would have gone all right if something had not gone wrong; and, since it is always the unexpected that happens, no chances whatever should be taken any more with gas in a mine than with powder.

When men will run risks with open lights it becomes a case of either too much ventilation or an abuse of ventilation. If there had been no use for safety lamps in the mines in which these accidents occured there might be some extenuating circumstances; but safety-lamps were required in some part of each mine. Had all been required to use safety-lamps the men would have run from the after-damp in the first explosion, they would have fixed the door in the second explosion, and they would not have used open lamps in the third explosion.

The men who lost their lives have not been accused of negligence, which means inattention to their duties or carelessness in the performance of their duties, because it is not clear that any of them were. It seems that they placed too much dependence on the ventilating current, which theretofore had answered all requirements; but there was too much ventilation, or the men would not have depended so implicitly upon it. Again, it is possible that the current was all right, but was abused in some manner so that it could not perform its functions properly, though not through any fault of the deceased.

It is not satisfactory to say that the deceased were negligent, but it is fair to say there was too much air or the ventilating current was abused. If the current had not been abused there would have been no after-damp in the first case; the door would have been repaired in the second place; and there would have been no accident in the last case, which is blamed to an open door.

This method of reasoning some of you will consider equal to that adopted for perpetual motion, where

Man eats fish,
Fish eat worms,
Worms eat man.

Is it not so?

There is more gas in the anthracite than in the bituminous coal mines, for which you men may be thankful. If the bituminous mines contained the same quantity of gas as the anthracite mines they would blow up weekly.

All rocks have pores, and contain quarry water. This works to the surface exposed to the ventilating current, and, under those conditions, where the mine air can absorb moisture, it will absorb it from the coal. This causes the coal to slack and offer surfaces for the air to abstract more water, and oxide as well. After the coal has become impalpable dust it is in an excellent condition to ignite, and when, from any reason, it does so, then a dust explosion occurs.

ENORMOUS FIRE LOSSES IN THE UNITED STATES

In a paper by Mr. Frank B. Gilbreth, presented at the October meeting in New York of the American Society of Mechanical Engineers, it was stated that the total cost of fires in the United States in 1907 amounted to almost half the cost of the new buildings constructed in the country for the year. The total fire loss, including that of forest fires and marine losses, amounted to over $456,485,000. In addition to this waste of wealth and natural resources, 1,449 persons were killed and 5,654 were injured in fires. The buildings consumed, if placed on lots of 65 ft. frontage, would line both sides of a street extending from New York to Chicago. A person journeying along this street of desolation would pass in every thousand feet a ruin from which an injured person was taken. At every three-quarters of a mile in this journey he would encounter the charred remains of a human being who had been burned to death. The results obtained indicate that the total annual cost of fires in the United States, if buildings were as nearly fireproof as in Europe, would be $90,000,000, and that therefore the United States is paying annually a preventable tax of more than $366,000,000, or nearly enough to build a Panama Canal each year.

AMONG THE DRAWBACKS OF CIVILIZATION

The following must be shouldered by the *British Medical Journal*:

In humanitarian circles it is customary to speak of civilization as a disease and to compare the noble savage and the effete citizen in a manner greatly to the latter's disadvantage from the point of view of health and constitution. Facts do not lend unqualified support to this kind of idealism, yet it must be confessed that the list of industrial diseases, already formidable, is a constantly growing one and that every new invention carries attendant evils in its train.

Among distinctively modern diseases may be instanced the poisoning produced by the fumes of calcium carbide or acetylene; the headache, dyspepsia, cardiac failure, and sensory disturbances traceable to the manufacture and use of aniline dyes; the frothing of the blood, known as caisson disease, which follows too rapid decompression in workers on the foundations of bridges; the functional neurosis known as telegraphists' cramp, resulting from the use of the Morse key, and the numerous affections of the skin, lungs, digestive tract and eyes due to irrattation by organic or inorganic dusts of industrial origin.

Among the last named special mention may be made of "shoddy fever," caused by the dust rising from pulverization of wool-containing rags. A modern danger par excellence is that of electrocution by contact with live wires, to which innumerable workers are daily and hourly exposed. Direct currents of 700 volts pressure and upward and alternating currents of half that amount are officially recognized as dangerous to life, but even lower charges have produced fatal results.

With the sad cases of Dr. Hall-Edwards and Dr. Kassabian fresh in their minds, medical readers do not need reminding of the terrible potentialities of the Roentgen ray. The conquest of the air is proving so costly to life that there is a growing feeling that its commercial exploitation by health and pleasure resorts in the form of "flying weeks" has been altogether premature, and should for the present be stopped. If therefore we cannot admit that civilization is itself in essence pathological, neither can we deny the costliness of its benefits or the pathogenetic associations of its every forward step.

WESTINGHOUSE GENERAL UTILITY MOTOR

The half tone shows one of the many applications of a general utility electric motor now being placed on the market by the Westinghouse Electric and Manufacturing Company. Its most evident line of employment is in domestic service, wherein by means of special attachments it can be applied to a variety of uses, and in light manufacturing its adaptability is unlimited. It can drive a ventilating blower as here shown, the family sewing machine, buffing, polishing and grinding wheels, jewelers' lathes, light machinery of all kinds, sign flashers, moving window displays, mechanical toys, etc. The small blower will supply fresh air to the kitchen, increase the draft of a furnace, remove foul air from sick rooms, and readily adapt itself to any small ventilating work.

The motor is light and has a handle by which it may be carried from place to place. It takes from 40 to 120 watts for its operation, running at 1700 r. p. m. It is made for operation on 115 or 230 volt direct current circuits, or on 110 and 220 volt alternating circuits of 60 or 133 cycles. The direct current motors are shunt wound while the alternating current motors are of the induction type, single phase. The motor is artistically finished in black enamel so that it would not look out of place anywhere.

Mountains of pure marble have been discovered in German South Africa, the like of which are unknown in the world.

ASBESTOS

The mystery of the mineral kingdom is asbestos. Many scientists look upon it as a sort of link between the mineral and the vegetable world. It might be said to resemble a mineralogical vegetable, possessing the curious properties found in both; for it is at once fibrous and crystalline, elastic and brittle, heavy as a rock when taken from the mines, but light as spun silk when treated mechanically. Soft, delicate almost as cobweb, the fibres of this strange mineral are so nearly indestructible that they have withstood the action of the elements since the world began. Through all the countless ages, during which the hardest rocks surrounding it have changed their characters, this geological freak has remained intact, having successfully resisted the assaults of fire, acids, and time. Historians are pretty well agreed that the strange mineral was known thousands of years prior to the Christian era, being prized by the ancients more as an article of extreme luxury or as a wonderful and interesting curiosity than as something of practical utility. The Egyptians of the earlier Pharaoh dynasties, engaged as they were in commerce with the Athenians, built up a considerable industry in the manufacture of what were known as "cere cloths," garments in which the mummified dead were wrapped for preservation. There is a specimen of asbestos textile in the museum of the Vatican library which was unearthed in Rome in the eighteenth century.

No evidence of this industry appears in modern writings until the early seventies of the nineteenth century, when experiments for using it commercially were made in Switzerland. Shortly after this the first specimens of a very fine, white asbestos, mined in Canada, were exhibited in London. They attracted little serious attention at the time, however, and it was not until 1878 that Canadian asbestos began to be mined on a large scale. Since then the Black Lake region of Quebec has been found to produce the finest fibre in the world, and now nearly 90 per cent. of all the asbestos used comes from the Dominion. Deposits are found, however, all over the world, notably in South Africa, but none of them produce the white fibre of the Canadian mines, their color ranging from blue and green to the recently discovered and very beautiful pink asbestos of India. The spinning and weaving of asbestos has offered many difficulties, as the asbestos fibres have no rough surface like wool or cotton, but are very smooth and thus have a tendency to slip by one another when twisted and subject to tension. An admixture of vegetable or animal fibre was therefore often necessary, but while these facilitated the manufacturing operations, they impaired the fire resistance of the fabric, and special machinery and ingenious devices had to be invented to enable the successful spinning of a pure asbestos yarn; it is, however, now possible to make a single asbestos thread a mile in length which weighs but a pound and a half.

RUST REVELATION IN THE DEMOLITION ON AN OFFICE BUILDING*

The Gillender Building, a seventeen story structure at the northwest corner of Wall and Nassau streets, New York City, was built in 1896 and removed in 1910. [See COMPRESSED AIR MAGAZINE, July, 1910.]

When built, all the columns were encased in solid brickwork. The steelwork received one coat of paint in the shop and two after erection, but on removal, showed little evidence of ever having been painted at all. From the top to the bottom, wherever the spaces between the brick and steel were filled with Portland cement mortar, there was no rusting, but, wherever the mortar did not fill such spaces completely, rusting had begun. Generally, the under sides of the top and bottom flanges of the floor-beams had begun to show rust, while the web and upper surfaces, having been in contact with mortar, were in good condition.

The worst rusting of all was from the sixth floor down, on the northeast corner, where the columns had been against the adjoining building, on the north side. The cover-plates of these columns looked as if they had never been painted, but had stood in the open, exposed to all weather, for six or seven years. On these columns one-half, in volume, of many rivet heads could easily be removed.

This building had been erected by first-class contractors and with first-class materials; and although the rusting had not yet made the building unsafe, there is no telling how soon it would have become so. It would seem

*A paper by T. Kennard Thomson. Proceedings American Society of Civil Engineers.

that if the columns had been encased and filled with wet concrete there would have been little danger of rust, and they could thus have been easily protected from electrolysis. Oil or oil paints should not be placed on steel to be thus encased.

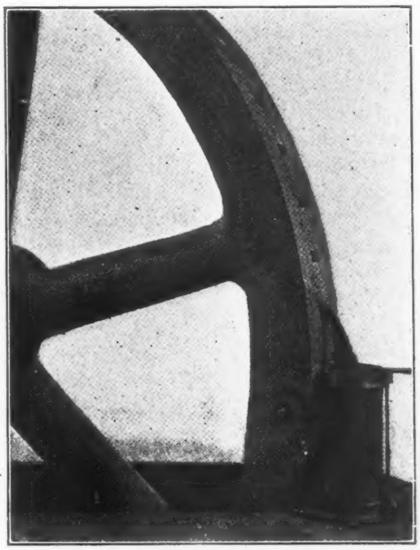
Messrs. Trowbridge and Livingston are the architects for the 39-story Bankers' Trust Building which will take the place of the Gillender Building, and Messrs. Marc Eidlitz & Son are the contractors, to whom the writer gives his thanks.

POSSIBLE REFINEMENTS IN STEAM PRACTICE

There may be steam-jacketed cylinders with infinitesimal clearances, and valves and pistons as tight as the proverbial bottle. Contraflo condensers equipped with air pumps of miraculous efficiency may produce vacuums rivaling the comet's tail in tenuity. There may be boilers and economizers so correctly proportioned that the escape of a single heat unit is almost as improbable as the discovery of an honest professional politician. There may be water-weighing apparatus so accurately adjusted that it could on a pinch be used for a barometer, and the walls may be decorated with flue-gas analyzing apparatus that resembles a chemical laboratory in its complicated completeness. There may be continuous and intermittent steam-engine indicators, recording thermometers and pressure gages. Superheaters may furnish steam so dry that its own weight of water will scarcely moisten it, and besides there may be a chief engineer worth a congressman's salary. *Ad. page of Power and the Engineer.*

SOUTH AMERICAN RAILWAY ALTITUDES

The Antofagasta & Bolivia Ry. Co. can claim the distinction of having the highest railway in the world. This railway has a 2-ft. 6-in. gage. Over this route the company runs sleeping and day coaches from Antofagasta on the Chilian coast to Oruro, 574 miles distant. From Antofagasta the line gradually rises to an altitude of 13,000 ft., which is reached at Ascotan, 223 miles from Antofagasta, and the main line runs for many miles at an almost uniform level of 12,000 ft. above the sea. The claim in respect of being the highest line of railway in the world is made not for the Antofagasta main line, but for the branch line which runs from Ollague to Collahuasi, on which the rails are laid at the great height of 15,809 ft. above sea level. Moreover, even this great altitude will, it is stated, be exceeded on the branch lines now being constructed by the Antofagasta Co. from Rio Mulato to Potosi. This is a line of a meter gage, and it is believed that the rails will reach a height exceeding 16,000 ft. At the present time the distinction of possessing the second highest railway in the world may be claimed for the Oroya Railway in Peru, where the line attains an altitude of 15,583 ft. The third highest line of rails is on the Peruvian Southern system, where a height of 14,665 ft. is reached at Portez del Cruzera. The greatest height prevailing on the Argentine and Chilian Transandine Ry. is 10,466 ft.



THE BADGER PNEUMATIC ENGINE JACK

The little halftone seems to tell all there is to be told about the Pneumatic Jack built by the Wisconsin Engine Company, Corliss, Wis., for helping an engine or an air compressor over the center. On large engines, and particularly on engines getting hard service, and quite generally on heavy air compressors, the jack should be a saver of time and labor. It may be fastened down in proper position and permanently piped or it may be moved around from one wheel to another and connected with a small hose. The pawl swings back out of the way as soon as the wheel starts.

OLD MEASURES RETAINED IN ENGLAND

It is not generally realized in the United States to what extent the old units are still retained in use in Great Britain. It is pretty well known that the U. S. gallon differs slightly from the imperial gallon; but the following from the London *Times* of Sept. 10, indicates that other gallons still persist in England.

"At a recent meeting of the Central Association of Dairy Farmers recommendations were agreed upon as to the London prices for Michaelmas contracts for the supply of milk. The prices were as follows: For short-distance railway transit milk 10d. and 8d. per imperial gallon, and for long-distance railway transit milk 9½d. and 7½d. per imperial gallon. These prices represent respectively 1s. 9d. and 1s. 5d. and 1s. 8d. and 1s. 4d. per barn gallon."

From the above it would appear that the "barn gallon" is a trifle more than double the imperial gallon. The only conjecture possible is that the "barn gallon" of milk must be a peck measure full.

In measures of weight, while in the United States all units except the pound and ton have become obsolete, except of course in the drug and jewelry trades, and the short ton of 2,000 lbs. has driven out the "long" ton of 2,240 lbs., except in the coal and ore trade, the English still cling to the "hundred weight" which is not a hundred pounds but 1/20 of a "long" ton, the only ton in England, and also to the "quarter" and "stone." Penny-in-the-slot weighing machines in England always show a person's weight in "stones."

Market customs are even more confusing to the uninitiated than the varying weight units. The following are the units in which current quotations are made of principal products on the London market: Barley, per 400 lbs.; Maize, per 480 lbs.; Oats, English, per 312 lbs.; Oats, Russian, per 304 lbs.; Rice, per cwt. Wheat, English, per 480 lbs.; Manitoba, per 496 lbs.; October in Liverpool, per 100 lbs.; September in Chicago, per bushel. Hay, per load. Linseed, California, per 410 lbs.; La Plata, per 416 lbs.

The same paper containing the above quotations advertises many parcels of land for sale with the area given in acres, roods and perches. We may also note that the furlong still survives in the English race courses.

OZONE IN FRANCE

Writing from Nice, France, U. S. Consul Hunter gives a brief description of the ozone water sterilization plant used for purifying the public supply of that city. Two plants were built in 1909, one with a capacity of about 3,400,000 gallons a day and the other with double that. Each of these is composed of two systems in duplicate to insure continuous action. He reports that a new plant is under construction which will have sufficient capacity to supply all the towns and cities between Nice and Mentone, a distance of 24 miles.

The water to be sterilized operates turbines used for generating the necessary electric current. This is produced at 110 volts, which is transformed into an alternating current of 17,000 volts, at which potential it is used. There are five so-called batteries, each consisting of three vertical copper plates two feet square and 1½ inches thick, with a space of 8 inches between them; in each of which spaces is a pair of glass sheets, between which the electric discharge takes place and the air is drawn by a suction machine. The ozonized air is passed through a vertical vitrified pipe containing charcoal dust and pieces of cement. To bring the water and ozone in contact, the former, under a head of 12 feet, is sprayed through openings in 1-inch pipes into a chamber filled with the ozonized air. The water then flows through 3 feet of pebbles from which it drops like rain to the bottom of a tank, passing, in so doing, through a strong current of ozone, a part of which is absorbed by it.

ELECTRIC SHOCK

At the recent meeting of the British Medical Association Dr. S. Jellinek, of Vienna, read a paper on "Disorders and Death Following Electric Shock." He stated that, while in some cases fatal accidents had been brought about by shocks at 100 volts, in other cases, in which the voltage had been 1,000, and even 10,000, recovery had ensued. In order to understand a matter so seemingly inconsistent, the doctor stated, it should be kept in mind that the danger of an electric current depended on circumstances which might be placed in the following two categories: 1. The external: (a) voltage, (b) amperage, (c) number of poles, (d) the time limit of contact, and (e) the

kind of current (a.c. or d.c.). The continuous current appeared to be more dangerous than the alternating. 2. The individual: (a) the resistance of skin and body, (b) the path of the current through the body, or over the surface of the skin, and (c) the condition of mind and body. The speaker stated that electric lesions were painless. With regard to the mechanism of death by electricity there was no definite scheme or model. In most cases it seemed like suspended animation. It was an interesting fact that there was between electric shock and death an interim of a few seconds in which the stricken person appeared to be quite in normal state. By experiments on dogs in the physiological institute of Prof. von Tschermak it had been discovered that the irritability of the brain, which had subsided immediately after a shock, had a few seconds later become re-established, and everything then depended upon whether the action of the heart would be continued or not. As there were sometimes haemorrhages in the brain, and as the pressure of the cerebrospinal liquid was increased, it was necessary and important in cases of first aid to lay the patient with the head elevated.

TUNNEL VENTILATION

The three items following rather curiously come to hand on the same day:

Hollister, Cal., Aug. 29.—Asphyxiated by noxious gases within 200 feet of the mouth of the San Carlos tunnel in the New Idra quicksilver mine, was the fate on Sunday night of Foreman John Williams, his three daughters, Elvina, aged 15 years; Marie, aged 12, and Marjorie, aged 5, and a dog belonging to the family. The bodies were discovered last night. The tunnel is situated six miles from the mine proper, and is 2,500 feet long. Williams and his daughters were returning from the face of the tunnel and had nearly reached the open air when they were overcome.

Helena, Mont., Aug. 29.—A. E. Marshall, a fireman of the Northern Pacific Railway, was asphyxiated in the Mullan tunnel early this morning. Marshall was fireman on helper engine 3,010, and, with Engineer James Sheppard, was sent out to help train 1,615, extra west, over the Mullan hill. When the train reached the mouth of the tunnel the fireman on the helper, as is the custom, got into the caboose to ride through the tunnel, and according to the information received in Helena, the train broke in the tunnel. It was repaired, but when an attempt was made to start it a drawhead was pulled out of one of the cars. Marshall then left the caboose to go to the aid of the engineer, and it was while so engaged that he was overcome with gas and his life snuffed out. Engineer Sheppard also was overcome, but revived and was able to resume charge of his engine.

Mauch Chunk, Pa., August 31.—Because the ventilation system has proved insufficient at the depth penetrated, work had been suspended at the new drainage tunnel which is being driven by the Lehigh Coal & Navigation Company up the Nesquehoning Valley. The company placed powerful fans at each end of the tunnel, which are kept going day and night for the purpose of supplying the workmen with fresh air. This worked all right until the tunnel was driven one and one-half miles from each end, when the force of the fans was spent before reaching the workmen, who were compelled to quit for want of better air. The company will now have to open vent holes at different places, which, on account of the depth of the tunnel, will require several months, and meanwhile the work of further tunneling is suspended.

LARGEST ELECTRIC MOTOR

The 6,500 horsepower motor for driving the 60 inch universal mill at Gary was recently referred to as the largest motor in the world. A report comes from England, however, of a motor being built by the Siemens Bros. Dynamo Works, Stafford, which completely overshadows the Gary unit. The British motor, however, is designed for direct current and is of little more than half the weight of the American machine. The Siemens motor will develop 10,000 horsepower at 60 revolutions per minute with current at 920 volts. It is so designed that, at a later date, the voltage can be raised to about 1,400 volts, when it will carry peak loads of 15,000 brake-horsepower at 90 revolutions per minute. It will be coupled direct to a 36-inch cogging mill and a finishing mill, and will roll 2½-ton ingots down to rails in one operation without reheating. It is stated that the operator will be able to reverse the motor from full speed in one direction to full speed in the other nearly 30 times per minute.

NOTES

A large piece of opal, weighing about 60 lbs., was recently found at Whitecliffs, Australia, and sold to a German buyer. It was broken in halves while mining, the value being estimated at £2 per oz., or nearly £2,000 in full.

A rust-proofing process for iron and steel, called Coslettising, consists in boiling the articles to be treated in a solution of 1 gallon of water, 4 ounces of phosphoric acid and 1 ounce of iron filings. By this means a black coating is produced on the iron or steel surface which protects it from atmospheric or other corrosive influences.

Another use for aluminum has been found in combining it with gold to produce a metal that is said to possess a beautiful hue adaptable for wide use in the jewelry trade. The alloy is composed of about 78 per cent. gold, and the aluminum seems to give just about enough different colour to give a very artistic appearance.

O. Spencer, a farmer and stock raiser, owner of the famous pacing horse, Gratt, 2.02¼, who resides near Rich Hill, Mo., recently turned a bunch of hogs into the pasture and they immediately began very energetically to root up the sod, exposing shale. With very little effort Mr. Spencer opened a pit of excellent coal, the vein being seven feet thick.

The first of the large caissons for the foundations of the new piers of the Quebec bridge has been launched. The new superstructure will be 30 feet wider than in the previous plan and the new centre line of the bridge has therefore been located 15 feet up stream. The caisson measures 54 by 180 feet and weighs 1700 tons, while the caisson for the south pier 79 by 180 feet, will be the largest of its kind ever built.

Within ten years there has been a growth of copper production throughout the globe of over 90 per cent., and during the same period the United States output from domestic sources also shows an increase of 90 per cent. The United States refinery production from all domestic and foreign sources in 1909, however, was more than double the total production of this country and the American imports ten years ago.

For some time large growers of tomatoes, cucumbers and similar vegetables for the London market have been accustomed to inject steam into the soil with the view of destroying insects and slugs. The plan operates very well for that purpose, but the unexpected fact has developed that the soil thus treated increases greatly in fertility.

In half a century the United States Department of Agriculture has grown from a mere beginning to an institution with over 11,000 employes. Congress supplies it with an annual income for its expenditure in the neighborhood of $15,000,000, while half as much more is spent by the States in their agricultural experiments, colleges and experimental stations. Of its employes, nearly 3,000 are scientists, hundreds are administrative officers, and thousands are clerks and helpers.

The fixation of atmospheric nitrogen has made great strides in Europe during the past few years. It has recently been reported that a company, known as La Nitrogêne, now has a plant in operation at Roche de Rame, Hautes-Alps, for the production of nitric acid from atmospheric nitrogen. In this plant the Pauling process is employed, by which the fixation of the nitrogen is accomplished by means of electric-arc discharges. The electricity is generated by water power. The normal yield of the furnaces is stated to be from 60 to 70 gms. per kilowatt-hour. (0.1 to 0.115 lb. per horse power hour).

The following, suggesting the augmentation of our supply of rubber by the use of banana juice, is taken from a paper printed in British Guiana: "About two years ago, whilst experimenting with some banana juice, so as to find out how best to mordant it, a thick and pliable rubber was found to attach itself to the sides of the enamel dish which held the juice. The rubber was ultimately sent to England and to America, and it was found to be what is known as a synthetic rubber, and when compounded with other rubbers it appeared to have a distinct market value, by increasing both the weight and the value of the rubbers with which it was compounded."

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FRANK RICHARDS, - - Managing Editor
F. C. IGLEHART, Jr., - - Business Manager
W. C. LAROS, - - - - - Circulation Manager

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CONTENTS

THE NEW TOOL IN THE ENGINEER'S KIT

The skill of the workman is worth but little unless he has a proper kit of tools, and the range and excellence of his work will depend upon their variety and their condition of efficiency. The tools at hand often determine the way of doing a job, and a lack of the right tool often makes a job cost too much. We are all familiar enough with the puttering of the carpenter or the plumber who comes to do some repairing about the house without the proper means for doing it.

The mining and tunneling engineer, the planner and the executor of the larger works in rock excavation and stone construction, has his kit at command just the same as the workman. Although he does not lug his tools on his shoulder or personally handle them at all, still they are under his direction and must do his bidding. In the later years he has welcomed valuable additions to his kit, and these have so transformed his methods and quickened and extended his achievements as to make those of the ancients seem absurd, and even contemptible in comparison.

Prominent in the modern engineer's kit are rock drills and the high explosives. These have vastly cheapened his work, enabling him to accomplish so much and to do things so rapidly that he might be expected soon to be looking for other employment; yet, in accord with the general habit of progress, the work is piling up ahead of him faster than ever, and he is hustling to improve his facilities, especially by concentration and simplification at the power end.

The problem of the drive for the widely distributed machinery employed in mining, in tunneling and in the larger operations having to do with water transmission and improved facilities for navigation, is most urgent. Steam had it all its own way for a long time and claimed, after a fashion, to drive everything. Then came the rock drill insisting that only compressed air was good enough for it, and later we have electricity the most boastful and self-sufficient of all. Electricity has failed to make good, so far as the direct driving of rock drills is concerned, and now, mostly in consequence of that, we have extensive operations in progress where steam, compressed air and electricity each have their own pecu-

liar share of the work, while the desirability of one driver for all is apparent and urgent.

How much better would be the one general means of power transmission than the three, especially when there can in these days be but little question as to what in many cases it should be. Electricity we must have anyway for our lighting, and for all machinery which is essentially rotative it does its work with little loss at either end, or even along the way if it be not excessively long. Where, as often now happens, there are special reasons for the use of electricity as the means of power transmission it can do practically everything except to drive the rock drills.

This disability prevails no longer, having been immediately annihilated by the advent of the electric air drill. While this drill is an air operated machine as completely and entirely as any machine ever designed, it is just as completely, right up to the apparatus itself, an electric driven machine, and it has no source of power other than the wires which connect it to the generator. There are, moreover, no sacrifices or compromises involved in its employment, and nothing apparently but advantages upon its side. No rock drill strikes sharper, more efficient or more continuous blows, and no other drill does its work for so little power consumed. The cost of drill and pulsator is all that has to be considered after the current is provided.

The most remote and diverse conditions suggest the special adaptability of the electric air drill. It can be placed and operated at its best in locations inaccessible to any other drill. Some of our most valuable mineral deposits are in the most out of the way places, but the drill may be transported wherever men can climb, and a wire is all that is required to actuate it. In excavating for building foundations in our cities nothing could be so handy, as current is always on tap.

RADIALAX POSSIBILITIES

The Radialax, being mostly used underground in mining or tunnel driving, is normally an air driven machine. The Radialax principle would seem to be generally and widely applicable to operations in stone excavation, the working in fixed planes being dictated not only by the natural cleavage of the rock, but also by the planes which usually are required by the shapes of the finished blocks for building, monumental or other uses. As generally happens in the development of inventions, what is most obvious in the retrospect is delayed in its first inception until the less serviceable devices, each an improvement upon its predecessor, have been successively worked out and their deficiencies, as well as their possibilities, revealed. The Radialax is comparatively a newcomer; we may easily believe that all the possibilities for its employment and the advantages of it have not yet all been developed, and we may expect its more extensive employment in the future.

The Radialax comes along naturally as the successor and working companion of the stone channeler. The latter may be said to work normally with vertical bits or cutters, the cut being in a vertical plane, permitting liberal angular departures from the vertical in either direction of working, while the normal working of the Radialax would, perhaps, be difficult to determine. When cutting in a vertical plane its movement would be horizontal when working in its central position, but from this normal or central direction it would change constantly in both directions as it made the sweep of the cut. When working in the horizontal plane while its working movement would be constantly horizontal the lateral direction would be constantly changing. From either the vertical or the horizontal plane of working the Radialax operates with equal facility at any required angular pitch in either direction.

It not only carries cutters whose function is the same as that of the stone channeler, but it also works as a regular rock drill, putting in holes in any direction and to any required depth for blasting. It is quickly and easily adjusted for working in any direction and for either channeling or drilling, and the parts of the apparatus are easily separated into convenient weights for handling.

The special characteristics of the Radialax peculiarity qualify it for the variety of operations involved in the work of the coal mine, although the principal operation is a species of rough channeling in directions paralleling the strata, which seldom vary far from the horizontal. This horizontal working will consist of undercutting the seam so that the coal can be easily broken down, the most persistent operation of coal getting, or of cutting out of

bands of clay, which often occur in the middle of a seam and seriously impair the purity of the coal if not removed. Especially in this latter case some precision of location is required, with the greatest facility of movement, so that time will not be wasted; and in this the Radialax would seem to have it practically all to itself.

For the vertical channeling, if we may so call it, which occurs in coal getting, for entry driving, for shearing on either side in the rooms, or for center cutting, so that light shots will bring down the coal in large lumps and with the least shattering of the walls, the Radialax again approaches the ideal.

Each coal mine is different in some respects from every other, and the work of getting out the coal as cheaply and in as good condition as possible will vary in essential particulars. The most desirable characteristic of a machine for which a market may be expected must be adaptability, a readiness to work in all positions, in widely varying conditions, and to turn itself from one style of cutting to the other, as required, and for this the Radialax is eminently adapted.

In the work of driving subway tunnels in the large cities through solid rock under or close to the foundations of large and costly buildings, where it is imperative that the shock of the blasting shall not damage or even endanger the surroundings, central vertical cuts made in the headings previous to the blasting at the sides give spaces toward which the rock may break without destructive reactionary effects. There would seem to be many cases where this employment of the radialax, or its equivalent when found, should be officially enforced.

LOSS OF OXYGEN IN HYDRAULIC COMPRESSION OF AIR

In our September issue attention was called to the fact that the air delivered by the hydraulic compressing plant at Ragged Chutes, Cobalt District, Ontario, has considerably less than its due proportion of oxygen, analysis showing 17.7 per cent. instead of the normal 21 per cent. The following letter of Prof. Olin H. Landreth, Dean of Engineering, Union College, Schenectady, N. Y., offers a clear and convincing explanation of the effect observed and suggests that it must be a necessary accompaniment of the process. Prof. Landreth says:

The loss of oxygen in hydraulic air compression, mentioned in connection with the compressed air supplied to Cobalt mines, is due to the well known fact that water will absorb different amounts of different gases, just as it dissolves different weights of different soluble materials.

ABSORPTION OF OXYGEN AND NITROGEN IN WATER.

For oxygen and nitrogen, the accompanying table gives the approximate percentage by volume absorbed to the absorbing water. This is stated for normal pressure, or one atmosphere; for other pressures the weights of oxygen absorbed increase in approximately direct proportion to the pressure, but as the density also increases as the pressure, the volumes (as measured under the varying pressure) are about constant.

PERCENTAGE OF GASES ABSORBED TO VOLUME OF ABSORBING WATER—PRESSURE, ONE ATMOSPHERE.

Temperature, Deg. C.	Ogygen, Per Cent.*	Nitrogen, Per Cent.
0	1.027	1.856
5	0.891	1.630
10	0.787	1.450
15	0.704	1.307
20	0.635	1.191
25	0.575	1.096

*These are true percentages; ratios are 1-100 of the above percentages.

The figures given in the absorption table are for atmospheric oxygen and nitrogen, not single, separate gases. They therefore represent conditions just as one would find them in hydraulic compression. The table shows that water absorbs from 80 to 90 per cent. more nitrogen from the atmosphere than of oxygen.

OXYGEN ABSORBED MORE READILY THAN NITROGEN.

If, however, these tabular percentages be divided by 0.21 for the oxygen and by 0.79 for the nitrogen, being the proportions of each gas in one cubic foot of air, it is seen that for the same volume of gas offered for absorption, oxygen is absorbed more than twice as fast as nitrogen, and the composition of the air taken up by the water is richer in oxygen than the original air. As the absorbed air is mostly carried away by the water flowing from the uptake shaft, the air which remains and which is used for industrial purposes is poorer in

oxygen than the original air. The absorbed air is largely given up from the water, but only after the water has risen in the uptake till the pressure is reduced, and even then is largely held in minute globules which give the water a milky appearance.

PER CENT. OF GAS CONTAINED IN A GIVEN VOLUME OF AIR ABSORBED BY THAT VOLUME OF WATER.

Temperature, Deg. C.	Oxygen, Per Cent.	Nitrogen, Per Cent.	Ratio, O:N.
0	4.89	2.35	2.08
5	4.24	2.07	2.05

NEW BOOK

Compressed Air Theory and Computations, by Elmo G. Harris, C. E., Professor of Civil Engineering, Missouri School of Mines, in charge of Compressed Air and Hydraulics; Member of American Society of Civil Engineers. McGraw-Hill Book Company, New York. XII, 123 pages 6x9 inch, 14 cuts in the text, diagrams and tables. $1.50.

The following from the preface of this book assumes for it a status which we are compelled to accept. The author says: "As one advocating the increased application of compressed air and the more efficient use where at present applied, the author has prepared this volume for college-bred men, believing that such only, and only the best of such, should be entrusted with compressed air installations." On the first two pages there are assembled 38 formulas covering most of the problems involved in compressed air practice and the body of the work is devoted to their derivation and application, with copious practical examples. Following this are several original tables with others which are found in the standard pocketbooks.

TRADE PUBLICATIONS

Ingersoll Rand Products. Ingersoll-Rand Company, 11 Broadway, New York City. 80 pages standard size, 6x9 inches. This cannot be called a catalog; it merely gives brief sketches of the various types of machines and apparatus actually manufactured by the company, fuller description and detailed information being found in other publications which are furnished upon application. There is a long list of applications of compressed air and valuable tables of general application.

General Catalogue No. 102. C. W. Hunt Company, West New Brighton, New York. 112 pages and cover, 4x6½ inches. Briefly describes Coal Handling and Hoisting Machinery, Conveyors, "Industrial" Railways, Electric Locomotives, Electric and Steam Hoists, "Stevedore" Manila Rope. A noticeable feature is the effective use of little half tones, many of them less than one square inch.

From the Rotary Meter Company, 280 Broadway, N. Y. City, comes a brochure (without formal title) of 24 pages, 10¼x13½ inches, illustrating various applications of the meters manufactured by the company. These are used chiefly for gas and have capacities up to 150,000 cubic feet per hour or over. They are of course applicable to the measurement of air also within certain limits of pressure and volume.

Remington Kerosene Oil engines, Marine and Stationary. Remington Oil Engine Company, Stamford, Ct. 32 pages and cover 5⅜x7⅝ inches, copiously illustrated. These engines are of the valveless type, delivering a power impulse in each cylinder for each shaft revolution. Ignition is caused by a plug which remains red hot all the time when running. The engine has the advantage of using a cheap grade of fuel and avoiding all danger of explosion and is used with great success in small boats as well as for all stationary service.

COSTS OF WATER STORAGE

The latest issue to hand of the Barge Canal Bulletin gives an interesting account of the Delta reservoir under construction for securing a reliable water supply for the canal, the article concluding with a comparison of costs of various other reservoirs. The Delta reservoir may be expected to cost some $75 per million gallons of available capacity (including nearly $25 for land damages). Among large municipal water-supply basins in the Eastern States the Wachusett cost (exclusive of soil-stripping) about $135 (including about $60 for real estate), and the Ashokan is expected to cost $180, while the three principal projects of the New York State Water Supply Commission for power development and flood prevention are estimated at from $16 to $33 (the latter the figure for the Portage basin includes

$5 for real estate), and four great irrigating basins of the West, from $5 to $17 (including land at $0.20 to $1.16) per million gallons of available storage. For New York city work, $200 has been regarded as the normal cost of storage. In France few of the reservoirs have cost less than $100, many have exceeded $300 and some even $600. In India the cost of impounding water has been in several cases about $30 and in few more than $50. It thus appears that a rational comparison on this basis cannot be made without a detailed study of the conditions and requirements of individual cases; but these data seem to imply at least that in the Delta reservoir water is to be impounded at an expense relatively as low as in other Eastern basins of greater capacity, in which the unit cost should thus be less, and which have been chosen with like restrictions as to geographical location.

NOTES

An 18-in. rock drill, 9½ feet long, has recently been tested at Bendigo, Victoria, Australia, in the construction of wharves. The drill weighs about 3,000 lbs. and is capable of working in rock 40 to 50 ft. under water. The cylinder diameter is 8 ins. with a 12-in. stroke. The weight of the piston is 450 lbs.

Out of 1,690 steel hopper cars weighed during the month of April the average decrease in cars which had been weighed within one year, was 702 lbs.; on 478 cars weighed within two years, 1,052 lbs.; on 132 cars weighed within three years, 1,220 lbs.; 92 cars, four years, 1,242 lbs.; 75 cars, five years and over, 1,459 lbs. In May, 671 lbs. on one-year cars; 1,004 lbs. on two-year cars; 1,224 lbs. on three-year cars; 1,571 lbs. on four-year cars; 1.705 lbs. on five-year and over.

A strange gas explosion occurred at the Vandalia mine No. 10, near Dugger, Ind., when the roof of an abandoned room caved in and opened a small pocket of gas, which was ignited by the open lamps of the miners in an adjacent entry. Andrew Baxter was killed by a blow on the head. It is supposed that he was thrown by the force of the explosion against the side of the entry. Nine companions of Baxter who were in the entry with him escaped with their lives, but suffered severe bruises and burns.

The south shore of Buckeye Lake is proving to be a fine natural gas district, and the Ohio Fuel Supply Company, which has almost all of the territory in that district under lease, has recently drilled in two large wells. One of these tests over 3,000,000 cubic feet and the other over 4,000,000 cubic feet. The company now has several other wells under way in this district and this will be one of the sources of supply for the company this winter.

A coal dust burner using a jet of compressed air instead of a fan blast has been in successful operation for the past two years in a southern cement factory. Air at high pressure passes through a Koerting ejector nozzle and enters the kiln through a horizontal pipe. A vertical fuel supply opens into the horizontal pipe just beyond the discharge end of the nozzle, and between the nozzle and the kiln, the rapidly moving air-jet carrying the coal dust into the furnace.

A smoke preventer, known as the "Torpedo" apparatus, is in use in England. It is a hollow conical structure of special perforated firebrick blocks supported in the combustion chamber just back of the bridge wall and in the direct track of the gases from the grate. Air is admitted from a pipe passing through the ash pit. The firebrick blocks become red hot and the heated air readily combines with the unburned carbon and hydrocarbons. The makers are the Yorkshire Boiler Co., Ltd., of Leeds.

The six-mile summit tunnel of the Denver, Northwestern and Pacific Railway, planned some time ago, is now being seriously considered for construction. The proposed elevation is 9,190 ft. above sea level, while the present line across the range attains a summit elevation of 11,660 ft. at Corona. This summit is reached by grades as steep as 4 per cent., but the tunnel line would have grades not exceeding 0.7 per cent. The tunnel will be about 50 miles west of Denver.

The work on the new line from Arica, near the north end of Chile (formerly belonging to Peru), over the west range of the Andes to La Paz, in Bolivia, encounters serious obstacles. On a large part of the line there has been no rain for 40 years, and 75 miles of pipe

line have been laid to secure water while building. From a point 26 miles from the sea, 1,955 ft. above it, the ruling grade is 165 ft. per mile for 17 miles, and there is then a section of cog-wheel track for 25 miles, with a grade of 317 ft. per mile. The summit, 119 miles from Arica, is reached at Laguna Blanca, at an elevation of 15,120 ft. The Bolivia end of the line is over a high plateau and not particularly difficult.

Among the diseases incident to certain trades, there is a peculiar one to which workers in plants manufacturing chromates are subject. The thinnest portion of the septum of the nose is attacked and is gradually eaten away until the two nostrils form one channel for a portion of the space inside the nose. The disease then seems to have no further effect on the health of the worker. Preventive measures are the use of some bland oil or ointment in the nose and taking care not to touch the nose when any dust containing chromates is on the fingers.

Lightning on September 13th caused serious damage in the oil field northwest of Lawrenceville, Ill. Twenty-five tanks were destroyed and in each case lightning started the blaze. The Ohio Oil Company, the Silurian Oil Company and the Bridgeport Oil Company lost 20 250-barrel tanks filled with crude oil and five 1,600-barrel tanks, all full. The lightning also struck the gas line of the Bridgeport Oil Company, tearing it up and setting fire to the gas. The gas had to be shut off from the pipe line in order to put out the fire.

Rapid tunnel advance was made on the Catskill Aqueduct during September, 1910. Heading 3 N. of the Wallkill Siphon tunnel made an advance of 523 ft., the full section excavation keeping even pace with the heading. This tunnel is circular, 17 ft. diameter inside of neat line. It lies mainly in Hudson River shale, and the work of this heading during the month was in alternating layers of slate and sandstone.

In a paper read before the Académie des Sciences, M. Mahler states that he finds that under the influence of dry air at 25 to 30 degs. Cent., 150 grammes of coal give rise in thirty hours to 1 cubic centimetre of carbon dioxide and 2.88 cubic centimetres of carbon monoxide. At 100 degs. Cent. the production of gas is nine times as great, and carbon dioxide predominates; but 100 degs. Cent. is very far from any ordinary storage temperature. It is shown that moist air has less effect, and thus justification is found for the practice of storing coal in the open, and spraying it in dry weather.

It is thought that the old Caylloma silver mines in Peru are at a greater elevation than any other big mine in the world. Their altitude varies between 14,000 and 17,000 feet. They were worked by the Spaniards in the sixteenth century and before that, it is believed, by the Incas. A year ago an English company prepared a hydro-electric plant for them. This plant is situated at an altitude of between 15,000 and 16,000 feet. It derives its power from a waterfall on the Santiago River, and in a dry season from Lake Huaillacho, one of the sources of the Amazon. The power is transmitted by cable about three miles.

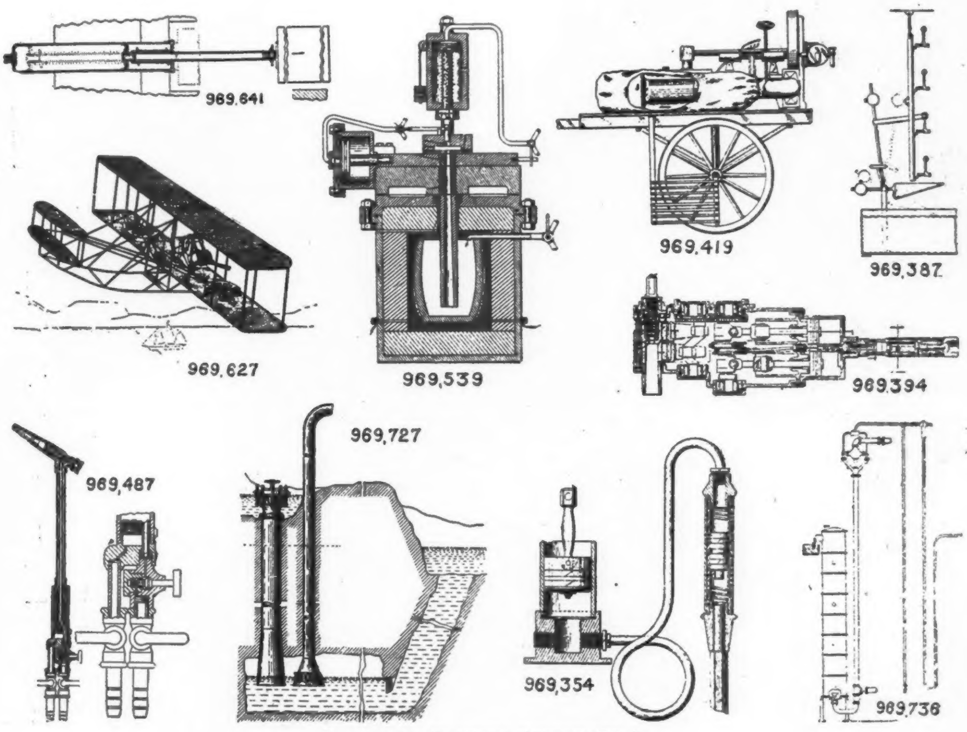
A little over a year ago there were less than 100 aeroplanes in all Europe, principally in France. Since the first cross-channel flight, Bleriot has built 250 machines, duplicates of the machine in which he crossed from Calais to Dover, and Farman has built at his works over 100 biplanes. The machines built by other makers bring the French production to over 800 which have sold for something over $2,500,000. The small Bleriot monoplane sold at first for $2,000, but after its success in crossing the English channel, the price was raised and the latest type now costs from $3,100 to $5,100; the price of the Farman machine is $5,600; Voison, $4,600; Antoinette, $500; Wright, $5,000; and Sommer, $5,000.

The South Metropolitan Gas Company, which supplies with gas a large district in the southern part of London, had the selling price of its gas fixed in 1900 by Parliamentary enactment at 3s. 1d. (75 cts.) per 1,000 cu. ft., with the privilege of paying annual dividends not exceeding 4 per cent on its capital. For each penny (2 cts.) which the company should reduce the selling price of gas, it was privileged to add 2s. 8d. to the annual dividend on each £100 of its capital. This is equivalent to adding about 1/7 of 1 per cent. to its dividend for each penny reduction in the price of gas. The company is now selling gas at 11d. below

the legal rate, or a net price of 53 cts. per 1,000 cu. ft., and has increased its dividends correspondingly, so that its stock now pays nearly 5½ per cent. Over one-third of the company's sales are in the poor districts of South London, where the gas is sold through slot meters.

According to the African papers there have been made during the past few years a great number of improvements in the dynamite works at Modderfontein, near Johannesburg, which have led to the discovery of a new explosive which in use does not develop noxious gases. The new explosive, a variety of gelignite, is cheaper as an explosive than the gelatine heretofore used. The principal saving resulting from its use consists in the fact that it reduces considerably the cost of ventilating the mines; and that work may be resumed in the latter as soon as a blast has been made. Experiments have also shown that much of the noxious gases resulting from the use of explosives in mines has come from the fuses and the paper shells in which the explosives are wrapped, so that in future there will be used no shells at all, or at least a simple tin-foil wrapping, and the ignition will be entirely by electric spark (relay ignition).

While cutting a deeper channel in the Mud River, Ohio, a dredge struck a water vein. The water gushed up and almost at the same time all the wells on adjoining farms went dry. Fears are entertained that Urbana may lose its supply if contemplated river improvements are carried out there, because a vein of water from which the supply is taken passes under the city in places only 15 feet from the surface.



PNEUMATIC PATENTS SEPTEMBER 6.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

SEPTEMBER 6.

969,200. OCEAN AIRSHIP. REINHOLD SCHMIECHEN, Ledyard, Iowa.

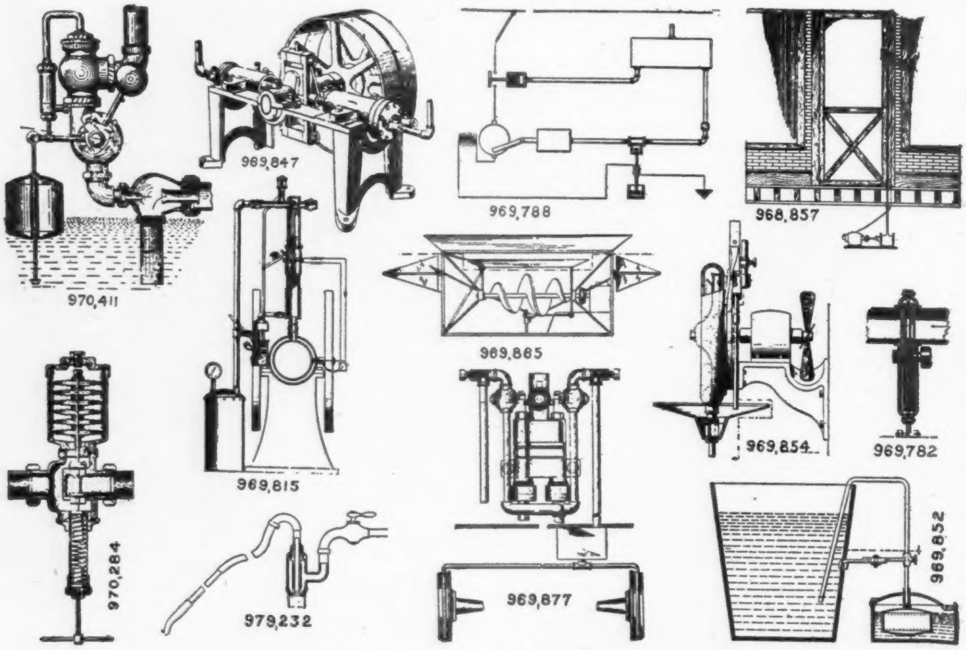
969,287. AIR-WASHING APPARATUS. JOHN H. KINEALY, Ferguson, Mo.

969,354. PNEUMATIC STONE-MARKING TOOL. CORNELIUS S. FELUMLEE, Newark, Ohio.
969,394. PNEUMATIC DRILL. REINHOLD A. NORLING, Aurora, Ill.
969,419. COTTON-PICKING MACHINE. HARRY JAMES STOOPS, Houston, Tex.
969,439. POCKET PNEUMATIC CUSHION. CALVERT B. ARCHER, Milford, Mass.
969,441. VACUUM-CLEANER. GEORGE BACKER, Syracuse, N. Y.
969,479. AUTOMATIC FLUID-PRESSURE-RETAINING VALVE. CHARLES W. HURL, Altoona, Pa.
969,487. BLOWPIPE. RUSSELL W. MAGNA, Holyoke, Mass., and LOUIS G. W. CARPENTER, Philadelphia, Pa.
969,519. PRESSURE-REGULATOR. JOHN ROWLAND BROWN, Mansfield, Ohio.
969,522. WINDMILL. JOHN A. CARLSON, Chicago, Ill.
969,539. CASTING APPARATUS. FREDERICK T. KITCHEN, New York, N. Y.

troducing air into the water by suction due to the downflow from the source, and a standpipe whose lower end is open and protruding into said chamber, the lower portion of the standpipe within the chamber being perforated for the entrance of air, after the air pressure has forced the water in the chamber downward to uncover said openings.
969,736. APPARATUS FOR STERILIZING AND OXIDIZING LIQUIDS WITH OZONE. ALEXANDER H. TWOMBLY, Summit, N. J.

SEPTEMBER 13.

969,772. SYSTEM AND APPARATUS FOR PROPELLING VEHICLES BY COMPRESSED AIR. JULIUS O. COBB, Milwaukee, Wis.
1. The combination with a track and a car movable thereon, of propelling vanes carried by the car for propelling it in one direction, other propelling vanes also carried by the car for propelling it in the opposite direction, nozzles



PNEUMATIC PATENTS SEPTEMBER 13.

969,547. OZONIZER. OSCAR LINDER, Chicago, Ill.
969,587. WIND-MOTOR. WILLIAM A. WILLIAMS, Olivet, S. D.
969,627. PROPELLING AND STEERING DEVICE FOR AIRSHIPS. EDWARD HOULT, New Westminster, British Columbia, Canada.
969,637. AIR, STEAM, OR HOT-WATER COUPLING. GEORGE N. KNAPP, St. Louis, Mo.
969,641. AIR-CHECK FOR SLIDING DOORS. HOMER LAUGHLIN, JR., Los Angeles, Cal., and DANIEL SCHUYLER, Bridgeport, Conn.
969,727. WATER-ELEVATING APPARATUS. OLAF A. ROED, Denver, Colo.
1. The combination with a subterranean chamber and a water supply source above the chamber, the latter having an outlet above the top of the chamber but below the source of supply, of an open-ended conduit extending downwardly from the source of supply, its lower extremity protruding into the chamber, the upper extremity of the pipe being equipped with means for in-

adapted to direct compressed air against said vanes for propelling the car, a pipe to conduct compressed air to said nozzles, valves to control the flow of compressed air from said nozzles and skees carried by the car and operable therefrom to actuate said valves.
969,782. FLUID PULSATING APPARATUS. CHARLES C. GLIDDEN, Birmingham, Ala.
969,788. FLUID-PRESSURE SYSTEM. CHARLES E. LORD, Norwood, Ohio.
969,815. STARTING DEVICE FOR INTERNAL-COMBUSTION ENGINES. FRANK H. WALKER,, Atwood, Kans.
1. The combination with an internal combustion engine, of a carbureter, means to generate and store compressed air, a pipe connecting said means with the engine cylinder, having branches extending into and from the carbureter, a starting valve in said pipe, and means actuated by said first named means to automatically close the starting valve when the engine starts.
969,847. PNEUMATIC PUMP. THOMAS DAVIS, Orange, N. J.

969,852. DRINKING-FOUNTAIN FOR POULTRY. FRANK ENOS, JR., Norwich, Conn.

969,854. HUMIDIFIER. JOHN W. FRIES, Winston, Salem, N. C.

969,857. FLY-FRIGHTENER. AUGUST W. GROVE, Chicago, Ill.

In a device of the kind described, the combination with a door, a motor, a blower operated by said motor, pipes connected to said blower and extending adjacent the vertical free edge and upper longitudinal edge of said door, said pipes having openings formed therein for directing a blast of air from the blower, and means carried by the door jamb and the door for automatically starting and stopping the motor when said door is opened and closed, respectively, substantially as described.

969,865. AEROPLANE. ANDREW A. HEIL, St. Louis, Mo.

969,877. AIR-BRAKE SYSTEM. OSCAR JOHNSON, Chicago, Ill.

970,183. PNEUMATIC STACKER. GEORGE F. CONNER, Port Huron, Mich.

970,232. VACUUM CLEANING APPARATUS. WILLIAM H. JAKWAY, Syracuse, N. Y.

HENRY J. RANDOLPH HEMMING, Washington, D. C.

970,703. MECHANICAL BELL-RINGER. GEORGE J. GOLLMAR, Baraboo, Wis.

970,771. FLYING-MACHINE. JOHN W. WILSON, Boston, Mass.

970,829. TOY-FLYING-MACHINE. ISAAC W. HUMPHREY and HARRY A. SPURGEON, Dayton, Ohio.

970,842. AERIAL NAVIGATION. RICHARD P. MARABLE, Yuma, Ariz.

970,914. HYDROPNEUMATIC PUMP. JESSE B. GARBER, Salem, Ohio.

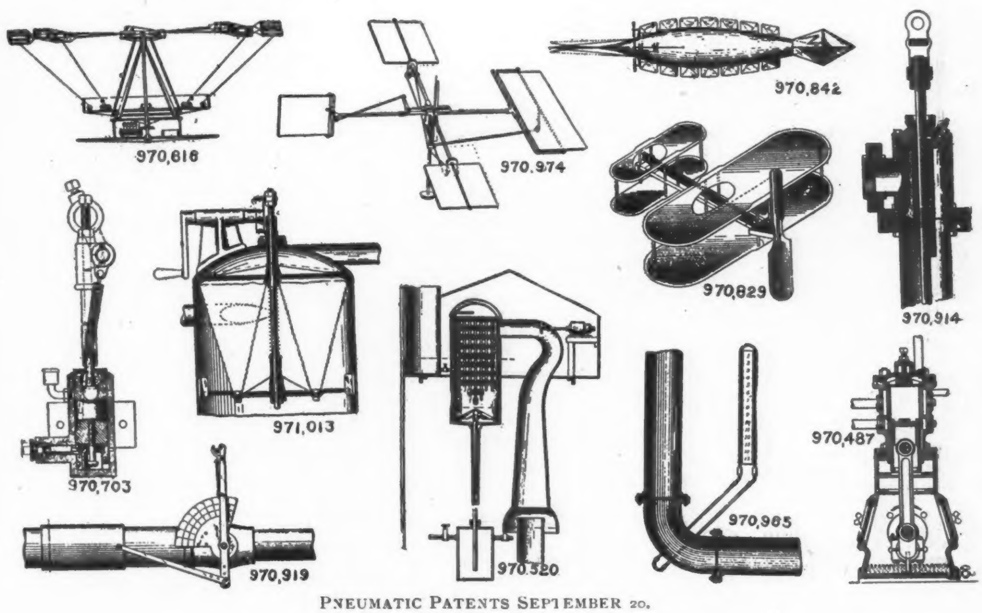
970,919. AIR AND GAS MIXING DEVICE. STEPHEN H. HALE, Neodesha, Kans.

970,923. MEANS FOR MEASURING OR ANALYZING GASEOUS MIXTURES. BERTRAND CHASE HINMAN, London, England.

970,956. PNEUMATIC STACKER. FREDERICK L. RUDDELL, Georgetown, Ontario, Canada.

970,965. METHOD OF MEASURING THE FLOW OF FLUIDS. JAMES BUCKNER SPEED, Berkeley, Cal.

2. A process of measuring the rate of flow of a fluid which consists first in causing the fluid to flow through a curved conduit which is filled by



PNEUMATIC PATENTS SEPTEMBER 20.

970,284. FLUID-PRESSURE VALVE-REGULATOR. THOMAS M. WILKINS, East Randolph, N. Y.

970,411. VALVE MECHANISM FOR CONTROLLING FLUID ADMISSION. GEORGE WOODALL, New York, N. Y.

SEPTEMBER 20.

970,487. AIR-COMPRESSOR. JOHN WILLIS GARDNER, Quincy, Ill.

970,519. SMOKE SEPARATOR AND PURIFIER. VICTOR E. LOMBARD, Fort Smith, Ark|

970,520. SMOKE AND FUME CONSUMING APPARATUS. VICTOR E. LOMBARD, Fort Smith, Ark.

970,616. FLYING-MACHINE. THOMAS A. EDISON, Llewellyn Park, Orange, N. J.

970,621. CAN-TESTING MACHINE. CHARLES W. GRAHAM, Rome, N. Y.

970,623. PROCESS OF PRODUCING PURE OR MIXED AERIFORM ENVIRONMENTS.

the fluid and has a uniform circular cross section, and the center line thereof a constant radius of curvature for a part at least of the length of the curved portion; second, in measuring the difference between the pressures on the inner surfaces of the concave and the convex sides of said part; third, in computing the flow according to a suitable rule which takes into account the diameter of the circular section, the radius of curvature of the curved conduit where it is uniform, and the said difference in pressure.

970,974. FLYING-MACHINE. PETER ROBERT TORBRAND, Denver, Colo.

971,013. DUST-COLLECTOR FOR VACUUM-CLEANERS. FRIEND W. SMITH, JR., Bridgeport, Conn.

SEPTEMBER 27.

971,030. AEROPLANE. WILLIAM H. FAUBER, Nanterre, France.

971,044. HAND VACUUM-CLEANER. CHARLES G. HUTCHINSON, New York, N. Y.

971,047. VENTILATING-VALVE. GEORGE E. KNOWLES, New York, N. Y.

971,069. CONTROLLING-VALVE FOR FLUID-OPERATED MOTORS. CHARLES ALGERNON PARSONS, GEORGE GERALD STONEY, ALFRED QUINTIN CARNEGIE and ALBERT WILLIAM BOWERBANK, Newcastle-upon-Tyne, England.

971,099. GAS-CONTROLLER. FRED ELLIOTT YOUNGS, Detroit, Mich.

971,175. AIR-COMPRESSING APPARATUS. LYMAN B. DE CAMP, Berkeley, Cal.

1. The combination, of an air compressor, a pressure tank connected with the main of a water system, such main, a motor connected to drive the air compressor, a source of power to operate the motor, power-controlling means to turn power on and off the motor, a float in the tank connected to operate said power-controlling means and means to turn on and off the power as the water rises and falls in the pressure tank, an air pipe connecting the air compressor and air tank, air check means between the compressor and air tank, and a valved outlet from the tank.

971,188. ROTARY PUMP ON AIR-COMPRESSOR. CHARLES R. GETHER, Milwaukee, Wis.

971,215. VACUUM-CLEANER. WILLIAM H. RAKESTRAW, Bloomington, Ill.

971,223. HAMMER-DRILL. ALBERT H. TAYLOR, Easton, Pa.

971,227. DEVICE FOR DAMPING THE AIR IN CLOSED ROOMS. KARL ULRICH, Zweibrucken, Germany.

971,235. FLYING-MACHINE. MAURICE ACKERMAN, Washington, D. C.

971,248. HUMIDIFYING APPARATUS. WILLIS H. CARRIER, Buffalo, N. Y.

1. The combination of a humidifier, an auxiliary humidifier which is supplied with humidified air from said first humidifier and is provided with additional humidifying means, and means controlled automatically by the humidity of the air in the vicinity of said auxiliary humidifier for regulating the action of its humidifying means, substantially as set forth.

971,275. FLUID-PRESSURE REGULATOR. MAX JASPERSEN, Hamburg, Germany.

971,297. ART OF TREATING AIR FOR USE IN METALLURGICAL PROCESSES. JOHN B. MILES, St. Davids, Pa.

1. In the art of treating air, compressing the air, and cooling the air to a temperature varying as the pressure of the compressed air varies so that the amount of moisture in a pound of air remains constant.

971,298. SUCTION-BOX VACUUM-REGULATOR FOR PAPER-MACHINES. WILLIAM H. MILLSPAUGH, Sandusky, Ohio.

971-326. AIR-BRAKE PROTECTION-VALVE. WALTER V. TURNER, Wilkinsburg, Pa.

971,327. TRIPLE-VALVE DEVICE. WALTER V. TURNER, Edgewood, Pa.

971,329. PNEUMATIC STACKER. JAMES A. WALSH, Indianapolis, Ind.

971,358. AERIAL MACHINE. LEONARD E. CLAWSON, San Francisco, Cal.

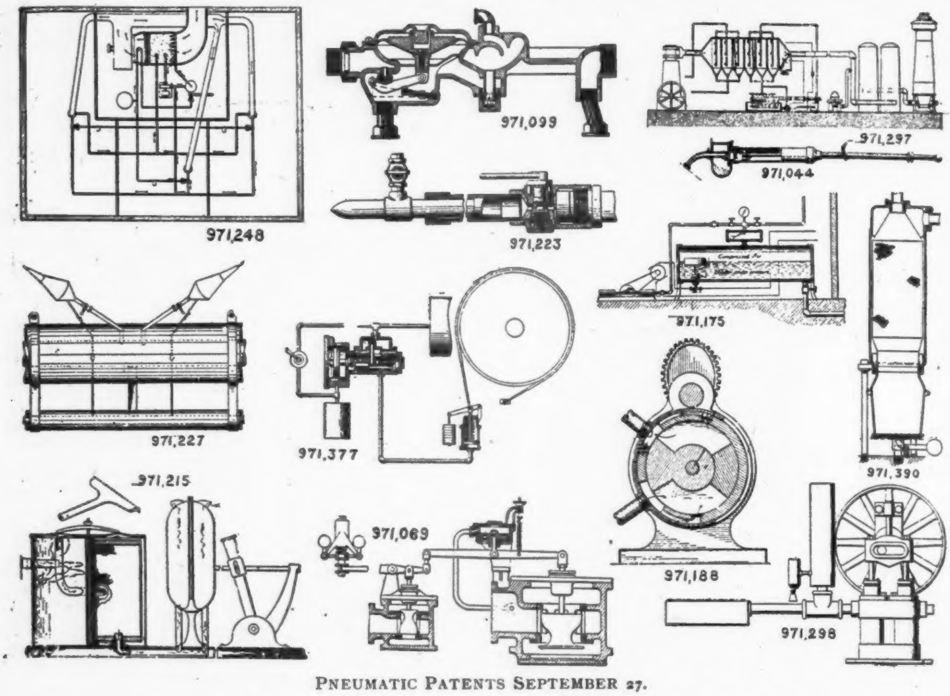
971,377. AUTOMATIC HOIST-BRAKE AND CLUTCH ADJUSTER. HERBERT T. HERR, Denver, Colo.

2. In a hoist brake, the combination with a spring for applying the brake, of a brake cylinder and a piston therein operated by fluid under pressure to oppose the spring, and means operating upon a reduction in fluid pressure to release air from said brake cylinder and cause the spring to apply the brake.

971,379. AIRSHIP. DAVID HILLIS, Des Moines, Iowa.

971,390. DUST-COLLECTOR. FRANK J. MATCHETTE, Milwaukee, Wis.

1. In a dust collector, the combination with a casing having an opening in the lower part thereof, a dust and air inlet and an air outlet, of a strainer bag inclosed in said casing between said inlet and outlet, and having an opening in its lower end, an elastic packing ring attached to the strainer bag around the opening in the lower end thereof and fitting the casing around the opening in the lower part thereof, and a removable closure fitted to said packing ring.



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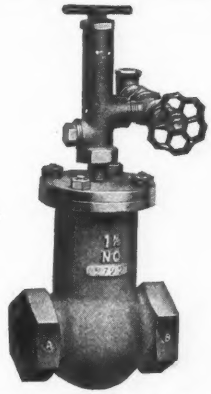

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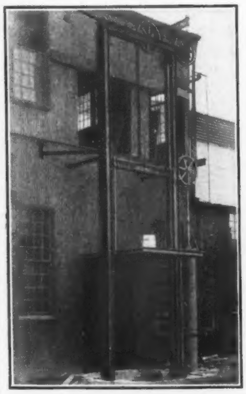


A pneumatic elevator with **no gear, no belt, no motors, no pulleys, no repairs** to wear out, break, burn out or need attention.

Absolutely Safe

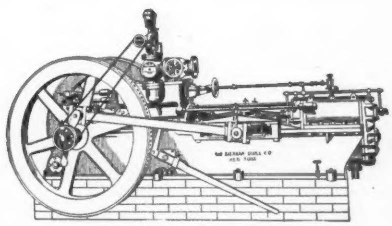
Cannot drop either from overload or failure of air supply. Cannot overtravel and wreck itself, being stopped by air cushions with **no jar at either level.** Hoisting and lowering speeds have independent regulators.

FIRE, WEATHER AND FOOL PROOF.

PUT 'EM ANYWHERE.

Curtis & Co. Mfg. Co.

1590 Kienlen Ave., ST. LOUIS, Mo.



AIR COMPRESSORS

ALL STYLES—ALL SIZES

EMBODYING LATEST IMPROVEMENTS

ROCK DRILLS

McKIERNAN DRILL CO

115 Broadway, New York City

Hoisting Machinery.
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American Metal Hose Co.
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Clark Co., W. J.
Cleveland Pneumatic Tool Co.
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McKiernan Drill Co.
Sprague Electric Co.
Sullivan Machinery Co.
Westinghouse Air Brake Co.

Hose, Sand Blast.
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Hose, Steam and Air.
American Metal Hose Co.
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Curtis & Co., Mfg. Co.
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Locomotives, Compressed Air.
Baldwin Locomotive Works.
Galigher Machinery Co.
Porter Co., H. K.

Lubricating Graphite.
Jos. Dixon Crucible Co.
Galigher Machinery Co.

Lubricating Greases.
Borne, Scrymser Co.
Fiske Bros'. Refining Co.
Galigher Machinery Co.

Lubricating Oils.
Atlantic Refining Co.
Borne, Scrymser Co.
Continental Oil Co.
Fiske Bros'. Refining Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
Standard Oil Co.
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Lubricators.
Powell Co., Wm.

Magnetic Separators.
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Meters, Air.
Ingersoll-Rand Co.
Metric Metal Works.
St. John, G. C.

Mining Machinery.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan Drill Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Motors, Air.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
Stearns-Roger Mfg. Co.

Nozzles, Air and Sand.
Curtis & Co., Mfg. Co.
J. M. Betton.
Pangborn Co., Thomas W.

Oil Cups.
Galigher Machinery Co.
Powell Co., Wm.

Ore Concentrating Machinery.
Galigher Machinery Co.
Stearns-Roger Mfg. Co.

Pile Drivers, Pneumatic.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan Drill Co.

Pipe Joint Compound.
Galigher Machinery Co.
Jos. Dixon Crucible Co.

Plug Drills.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
Oldham & Sons Co., Geo.
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Pumping Systems, Pneumatic.
Bury Compressor Co.
Curtis & Co., Mfg. Co.
Galigher Machinery Co.
Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan Drill Co.
Stearns-Roger Mfg. Co.

Pumps, Air.
Cameron Stm.Pump Wks,A.S.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan Drill Co.
Stearns-Roger Mfg. Co.
Westinghouse Air Brake Co.

Pumps, Pneumatic Displacement.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan Drill Co.
Stearns-Roger Mfg. Co.
Westinghouse Air Brake Co.

Pumps, Steam.
Cameron Stm.Pump Wks,A.S.
Galigher Machinery Co.
Stearns-Roger Mfg. Co.
Westinghouse Air Brake Co.

Quarry Machinery.
Bury Compressor Co.
Cameron Stm.Pump Wks,A.S.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan Drill Co.

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